DEEP LAKE
LAKE CLASSIFICATION REPORT

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EXECUTIVE SUMMARY

Background Information about Deep Lake

Deep Lake, a natural seepage lake, is located in the Town of Jackson, Adams County in the Central Sands area or Wisconsin. It has 35 surface acres, with a maximum depth of 55 feet and a mean depth of 25 feet. This lake has no natural stream inlet or outlet and fed by precipitation, runoff and groundwater. Deep Lake is part of the Neenah Creek Watershed, a large watershed of 182 square miles which flows into the Fox River and eventually into Lake Michigan. There is no public boat ramp on the lake. The only public access is a staircase on the south side of the lake, owned by the WDNR. There are two Native American archeological sites, mostly burial mounds, located around Deep Lake that cannot be further disturbed without permission of the federal government and input from the local tribes.

The dominant soil in the ground watershed for Deep Lake is loamy sand, with slopes from very flat up to steep. There are also large areas of sand, sandy loam and gravel pits in the ground watershed. Sand and loamy sand evenly split most of the surface watershed. These soils tend to be well or excessively drained, no matter what the slope. Water, air and nutrients move through these soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Wind erosion, water erosion and drought are common hazards of these soil types.

Land Use in Deep Lake Watersheds

Both the surface and ground watersheds of Deep Lake are fairly small. The most common current land uses in the Deep Lake Surface Watershed are irrigated agriculture and woodlands. In the ground watershed, woodlands dominate the land use.

Deep Lake has a total shoreline of 1.28 miles (6758 feet). Most of the shore has been left unaltered so far, except for a small beach associated with a campground, a few grassy areas by docks, and the east end of the lake, where riprap covers the front of five small resort cottages. Most of the areas near the shore are steeply sloped, except at the far east end, where the land is flatter directly by the shore. Buildings are generally located 70 or more feet back from the shore, except at the far east end where there are six buildings built very close to the water's edge.

A shoreline survey was conducted in 2004. Shore types were categorized as "armored" and "vegetated". "Vegetated" shores encompassed both native vegetation of any type and mowed lawns. 78.83% (5327.4 feet) of Deep Lake's shoreline is vegetated (this includes mowed lawns). 15.17% (1025.55 feet) is armored. The remaining 6% (404.45 feet) is actively eroding.

The 2004 inventory also classified the Deep Lake shorelines as having "adequate" or "inadequate" buffers. An "adequate" buffer was defined as one having the first 35 feet landward covered by native vegetation. An "inadequate" buffer was anything that didn't meet the definition of "adequate buffer", including native vegetation strips less than 35 feet landward. The shore survey showed that more than 80% of the shore had an "adequate buffer." However, some 16% of the shore had an "inadequate buffer". Most of the "inadequate" buffer areas were those with hard structures, mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Deep Lake. Overall, Deep Lake was determined to be a mesotrophic lake with very good water quality and water clarity.

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Deep Lake was 18.42 micrograms/liter. This is below the 25 micrograms/liter average recommended for natural lakes in Wisconsin to avoid algal blooms. This concentration suggests that Deep Lake is likely to have few nuisance algal blooms. This places Deep Lake in the "very good" water quality section.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Deep Lake in 2004-2006 was 12.96 feet. This is very good water clarity. Records since 1992 show that the water clarity in Deep Lake has consistently remained high.

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-2006 summer (June-September) averagechlorophyll-a concentration in Deep Lake was 3.6 micrograms/liter, a low algal concentration. Chlorophyll-a averages have stayed low in Deep Lake since 1992, the first year for which records were found.

Low dissolved oxygen levels during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. As the summer progresses, the oxygen concentration of the bottom waters may decrease. In Deep Lake, there were hypoxic (low oxygen) periods in the depths from 25' to 50' during all three summers of 2004, 2005 and 2006. Besides being a potential danger to a lake's fish population, summer hypoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. The data collected at Deep Lake from 2004-2006 shows there is a potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in Deep Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on Deep Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

Surface water testing results for Deep Lake showed "moderately hard" water (145.6 mg/l $CaCO_3$). Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water. Hardness levels over 180 mg/l can cause marl lake beds to start precipitating out of the water or sediment, thus releasing phosphorus for aquatic plant and algae use. Since Deep Lake's hardness less is far below that, the marl in the lake is likely to keep binding a significant amount of phosphorus that would otherwise be in the water column.

A lake with a neutral or slightly alkaline pH like Deep Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Deep Lake.

Other water quality testing at Deep Lake showed no particular areas of concern. The average calcium level in Deep Lake's water during the testing period was 28.47 mg/l. The average Magnesium level was 19.32 mg/l. Both of these are low-level readings. Although the presence of a significant amount of chloride over a period of time may indicate that there are negative human impacts on the water quality present, chloride levels found in Deep Lake during the testing period were all below 3 mg/l, at about the natural level of chloride in this area of Wisconsin. Nitrogen levels can also affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Deep

Lake nitrogen-combination spring levels from 2004 to 2006 never rose to more than .085 mg/l, significantly below the .3 mg/l predictive level.

Both sodium and potassium levels in Deep Lake were very low: the average sodium level was 1.89 mg/l; the average potassium reading was 1.03 mg/l. To prevent the formation of hydrogen sulfate, levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Deep Lake sulfate levels average 6.05 mg/l during the testing period, far below either level. Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Very turbid waters may not only smell and mask bacteria & other pollutants, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Deep Lake's waters were all at very low levels.

Phosphorus

Like most lakes in Wisconsin, Deep Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a natural lake like Deep Lake, a total phosphorus concentration below 25 micrograms/liter tends to indicate few nuisance algal blooms are likely to occur. Deep Lake's growing season (June-September) surface average total phosphorus level of 18.42 micrograms/liter is low enough so that nuisance algal blooms should occur rarely and are probably localized.

In most lakes in Wisconsin, phosphorus concentration in the bottom sediments of the lake is considerably higher than the concentration in the water column itself. Bottom sediments can "bind up" phosphorus, making it unavailable for aquatic plants or algae to use. Some sediment types hold phosphorus at a higher rate than others. Deep Lake is lucky to have a substantial amount of marl in its sediments. "Marl" is a calcium carbonate precipitate (solid) that forms in hardwater lakes when both calcium and pH levels are high and has a high capacity to immobilize phosphorus and other nutrients. With such a large amount of marl sediment, Deep Lake may benefit from it removing phosphorus from water column, thus making it unavailable for algal and aquatic plant growth.

Land use plays a major role in phosphorus loading. The land uses in the Deep Lake surface watershed that contribute the most phosphorus are irrigated agriculture and woodlands. Some phosphorus deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as waterbody shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Deep Lake in-lake water quality by .7 to 3.9 milligrams of phosphorus/liter; a 25% reduction would save 1.5 to 9.75 milligrams/liter. Currently, both the spring turnover and summer phosphorus levels are below the threshold value of 25 micrograms/liter, but a phosphorus increase from human activities of only 25% would put the phosphorus levels in the lake over that threshold in the summer. The result would be more algal blooms and more aquatic plants. Decreases would reduce those problems. The modeling predictions make it clear that reducing current phosphorus human-impacted inputs to the lake are essential to improve, maintain and protect Deep Lake's health for future generations.

Aquatic Plant Community

The aquatic plant community of Deep Lake is characterized by good quality and good species diversity. The plant community suggests that Deep Lake is closer to an undisturbed condition than the average lake in the state. In the North Central Hardwoods Region, Deep Lake is in the group of lakes closest to an undisturbed condition.

The Deep Lake aquatic plant community has colonized 100% of the littoral zone. The 0-1.5 feet depth supported the most abundant aquatic plant growth. *Ceratophyllum demersum* (coontail) was the most frequently occurring plant species and dominant plant species in Deep Lake, although *Chara* spp. was the most frequently-occurring and dominant aquatic species. *Potamogeton amplifolius* and *Potamogeton zosteriformis*, both native submergent plant species, were sub-dominant.

Critical Habitat Areas

Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes. Two areas on Deep Lake—covering most of the lake's shores--were determined by a team of lake professionals to be appropriate for critical habitat designation.

Area DE1 extends along approximately 300 feet of the shoreline. 10% of the shore is wooded; 55% has shrubs; 25% is native herbaceous cover; 5% is rock and 5% is hard structure. Maximum rooting depth of aquatic vegetation in DE1 was 18.5 feet. This is a small area of the lake between a resort that has a rock-riprapped shore and a stairway and dock going to another residence. There are downed trees in the water at this site that provide fish habitat and wildlife structure. The large woody cover and submergent vegetation provides spawning and nursery areas for many types of fish. No filamentous algae were found at this site. One emergent exotic invasive was found in this area, *Phalaris arundinacea* (reed canarygrass). Ten species of submergents were found in DE1. The only emergent plant found was *Phalaris arundinacea.*

Area DE2 extends along approximately 4300 feet of the shoreline. 54% of the shore is wooded; 7% has shrubs; 28% is native herbaceous cover, with 10% rock, 7% hard structure and 3% bare sand. Large woody cover is abundant for habitat. There are shallow marsh areas along many areas of this shoreline. With only a little human disturbance along this shoreline, the area is scenic. One emergent exotic invasive, *Phalaris arundinacea*, was found in this area. 29% of the area has filamentous algae, especially near the shores. Of the twenty aquatic plant species found here, seven were emergent. Emergents provide important fish habitat and spawning areas, as well as areas for wildlife. Two plants were floating-leaf rooted plants. Floating-leaf plants provide cover and dampen waves, protecting the shore. The remaining eleven species were submergent aquatic plant species. Such a diverse submergent community provides many benefits. All these plants are used for multiple purposes. Because this site provides three structural types of vegetation, the community has a diversity of structure and species that support even more fish and wildlife diversity.

Fish/Wildlife/Endangered Resources

A 1948 fishery inventory of Deep Lake found that bluegills were abundant, black crappie & yellow perch were common, but other fish types were scarce. It described Deep Lake as "infertile, with moderate to scarce plankton, suitable for trout, moderate to sparse vegetation with little shallow area". It noted that there was not heavy fishing pressure on Deep Lake.

Stocking records go back to 1942 when perch and largemouth bass were stocked. Bluegills and largemouth bass were stocked through the 1940s. In the 1960s and 1990s, brown and rainbow trout were stocked. Inventories from 1953 through 1979 noted that largemouth bass, rock bass, bluegills and other panfish were abundant or common. Northern pike tended to be scarce. No fish inventory has been done on Deep Lake for several years.

Muskrat and mink are also known to use Deep Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. A blue heron rookery is known at the west end of the lake. Upland wildlife feed and nest here as well.

Conclusion

Deep Lake is currently a healthy lake with many positive aspects, as discussed in this report. The main focus of continued management should include shoreland restoration, integrated management of invasive species, reduction of human-impacts on phosphorus loading, well-managed land use and continued monitoring for water quality and invasive species. Care should be taken to maintain the overall excellent quality of the lake and its surroundings. Currently, Deep Lake is one of the few lakes with public access in the county without a significant invasive aquatic species problem. Deep Lake should have some kind of lake organization that can oversee the management of the lake to insure the lake maintaining its very good status. Considering the development pressure in Adams County around the lakes, benign neglect is unlikely to continue to be enough to preserve the lake's health.

The recommendations following should help in these aims.

RECOMMENDATIONS

Lake Management Plan

Deep Lake does not currently have any kind of lake organization, much less lake management plan. After the lake classification study, information necessary to write a lake management plan is available, but the first step must be to form a lake organization dedicated to preserving and caring for Deep Lake. When a lake management plan is written, the plan will need to include the following aspects concerning the management of the lake (and others): aquatic plant management; control/management of invasive species; wildlife and fishery management; watershed management; shoreland protection; critical habitat protection; water quality protection.

Watershed Recommendations

Although neither the surface nor ground watershed for Deep Lake is particularly large, results of the modeling certainly suggests that input of nutrients, especially phosphorus, are a factor that needs to be explored for Deep Lake.

Therefore, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans.

If such sites are documented, steps for dealing with these issues can be determined.

Shoreland Recommendations

All lake residents should practice best management on their lake properties, including keeping septic systems cleaned and in proper condition, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.

Aquatic Plant/Aquatic Invasive Species

Residents should become involved in the Citizen Lake Water Monitoring Program, Invasive Species Monitoring and Clean Boats, Clean Waters. This will allow not only noting changes in the Eurasian Watermilfoil patterns, but also help identify any new species. Noting the presence and density of these species early is the best way to take preventive action to keep them from becoming a bigger problem.

Water Quality

Residents should become more involved in the Citizen Lake Water Monitoring Program, Invasive Species Monitoring and Clean Boats, Clean Waters. Ongoing water quality monitoring will allow information to compare to the baseline results of the lake classification monitoring and permit a quicker response if water quality issues seem to be developing.

Any new or additional development, especially at the east end of the lake where buildings tend to be closer to the water, should be permitted only if there is an erosion control (including a buffer) and stormwater management plan.

Critical Habitat Recommendations

There are also several recommendations appropriate for the critical habitat areas.

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline nor logs in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Maintain or increase wildlife corridor.
(7) Maintain sedge meadow and deep marsh areas.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation for habitat and shoreline protection.
(10) Removal of submergent vegetation for navigation purposes only.
(11) Minimize aquatic plant and shore plant removal to maximum 30’ wide access/viewing corridor. Leave as much vegetation as possible to protect water quality and habitat.
(12) Use forestry best management practices.
(13) No use of lawn products.
(14) No bank grading or grading of adjacent land.

(15) No pier construction or other activity except by permit using a case-by-case evaluation.
(16) No installation of pea gravel or sand blankets.
(17) No bank restoration unless the erosion index scores moderate or high.
(18) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(19) Placement of swimming rafts or other recreational floating devices only by permit.
(20) Maintain buffer of shoreline vegetation.
(21) Maintain aquatic vegetation in undisturbed condition for wildlife habitat, fish use and water quality protection.
(22) Post landing with educational signs to prevent introduction and/or spread of exotic species.

LAKE CLASSIFICATION REPORT FOR DEEP LAKE, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and education lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a relative response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. Goals, priorities and action items may include educational programs, formation of lake districts, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

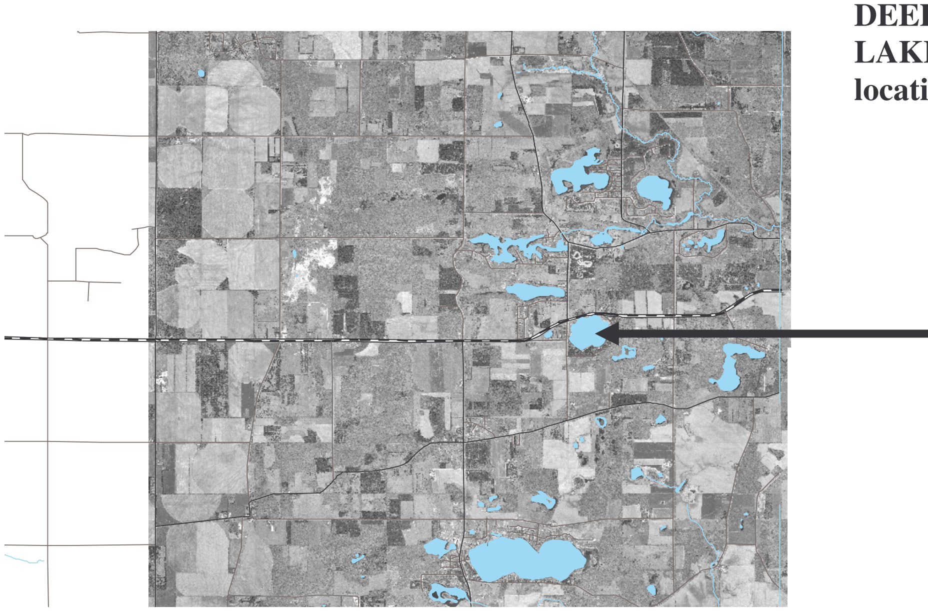
Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

Figure 1: Adams County Location in Wisconsin

DEEP LAKE BACKGROUND INFORMATION

Deep Lake is a 35-acre natural seepage lake located in the Town of Jackson, Adams County, in the Central Sands Area of Wisconsin. It has a maximum depth of 55 feet and a mean depth of 25 feet. A "seepage lake" is a natural lake with no natural stream inlet or outlet and fed by precipitation, runoff and groundwater. There is a WDNR-owned steep staircase that is the public access point for Deep Lake on the south side of the lake. There is no Deep Lake organization of any type.

Figure 2: DEEP LAKE location

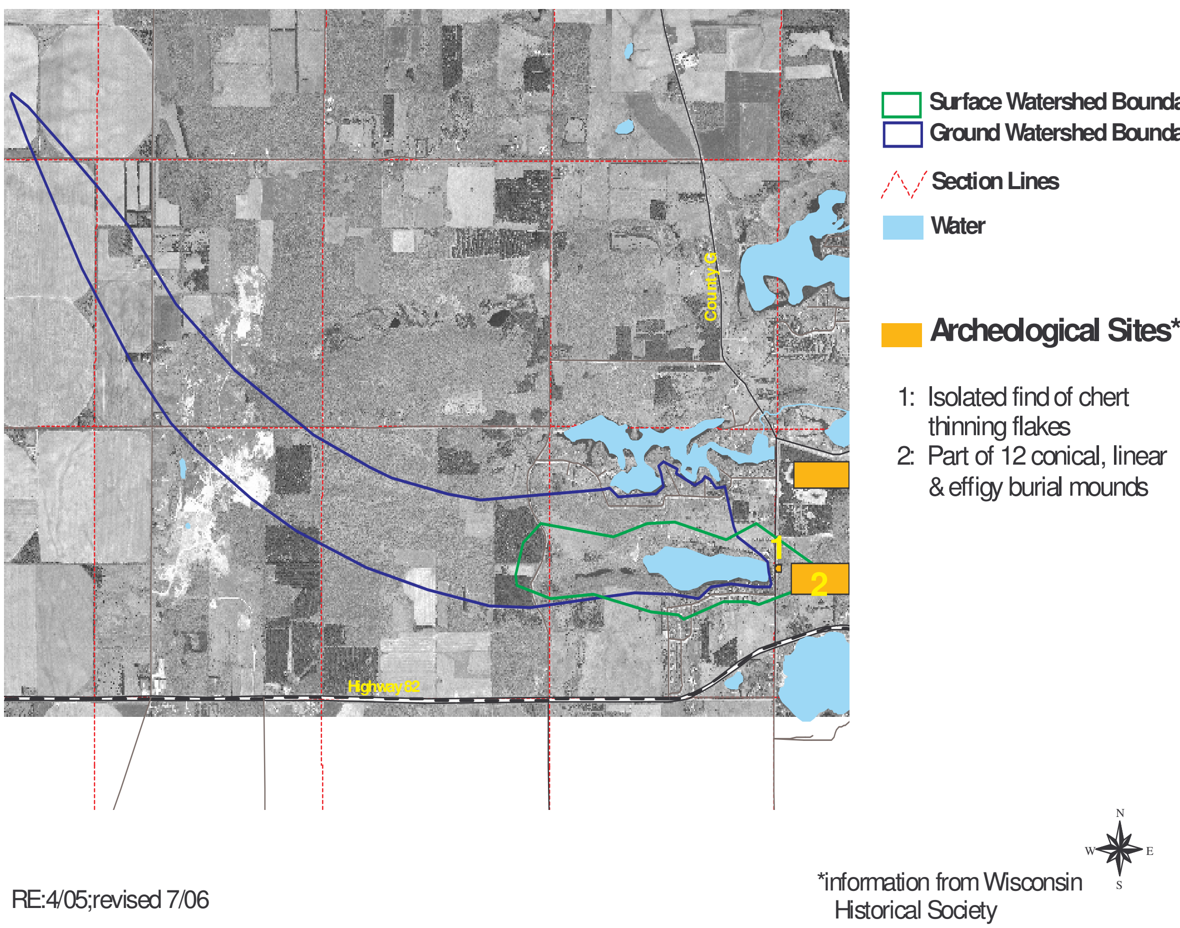


Deep Lake is part of the Neenah Creek Watershed, a large watershed of 182 square miles which flows into the Fox River and eventually into Lake Michigan. The Central Sand Hills, which contain Deep Lake, are an ecological landscape (a recessional moraine) on the eastern edge of what was Glacial Lake Wisconsin. The area is characterized by glacial moraines and glacial outwash, as well as the kettle holes that formed natural lakes—such as Deep Lake. Elevations average between 900 to 1000 feet above sea level.

Archeological Sites

There are many Native American archeological sites in Adams County, with some located near Deep Lake, including two burial mound groups. Under the federal act on Native American burials, these sites cannot be further disturbed without permission of the federal government and input from the local tribes.

Figure 3: Deep Lake Archeological Sites



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Bedrock and Historical Vegetation

Bedrock around Deep Lake is mostly sandstone, with pockets of dolomite and shale, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Bedrock is generally 50' to 100' down from the land surface. The water table in most areas around Deep Lake is fairly near the surface.

Original upland vegetation of the area around Deep Lake included oak-forest, oak savanna, pine barrens and tallgrass prairie. Wetland areas were also common, including wet-mesic prairies, wet prairie, coastal plain marshes and fen. Hills and kettles created by glacial deposits make up the southeast area of Adams County, where Deep Lake is located.

Soils in the Deep Lake Watersheds

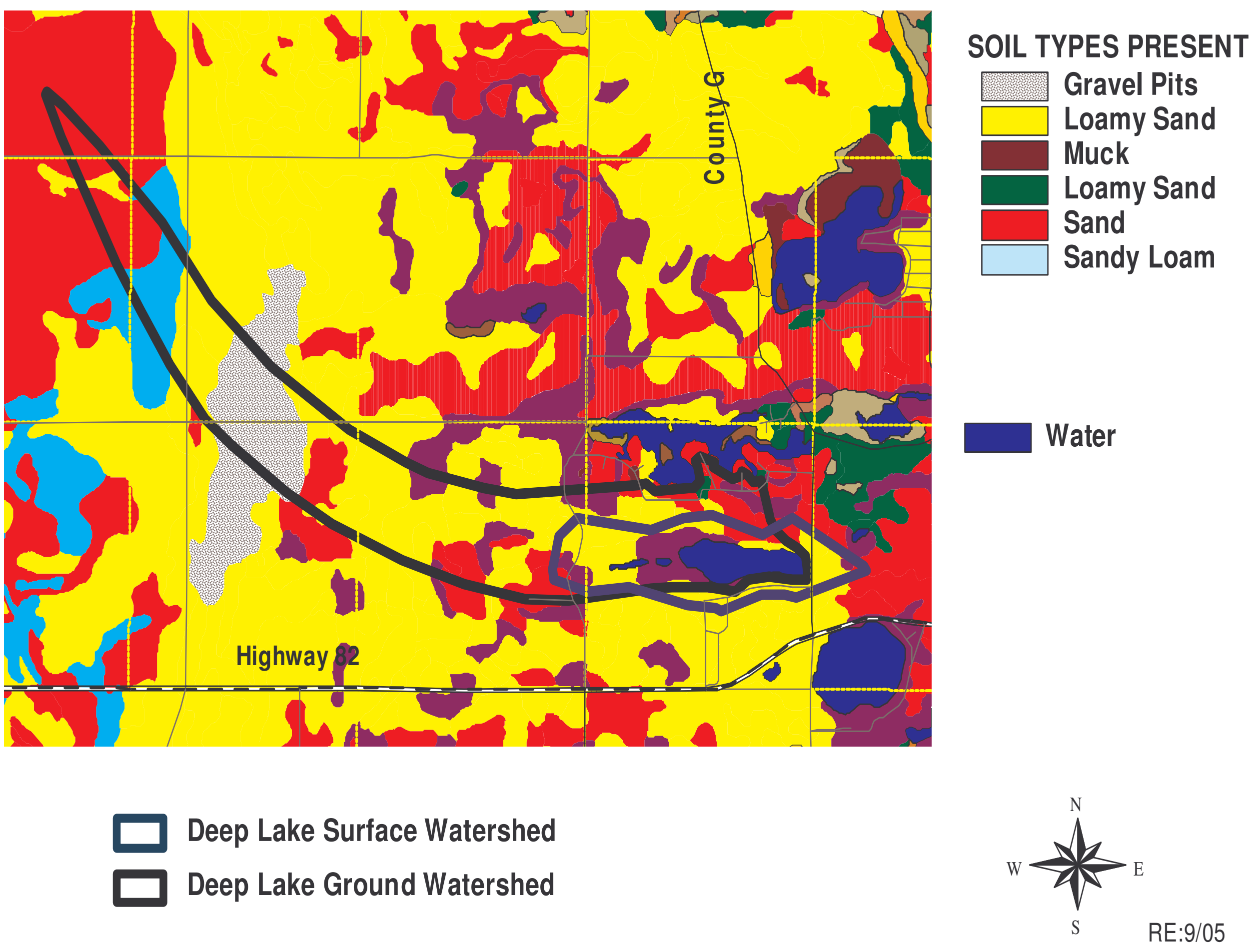
The dominant soil in the ground watershed for Deep Lake is loamy sand, with slopes from very flat up to very steep. There are also large areas of sand, sandy loam and gravel pits. Sand and loamy sand evenly split most of the surface watershed.

Sandy soils tend to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since they dry out so quickly. There are also drought hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Loamy sands and sandy loams tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. The same difficulties with waste disposal and vegetation establishment are present with loamy sands as with sandy soils.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

Figure 4: Deep Lake Watersheds Soils



CURRENT LAND USE

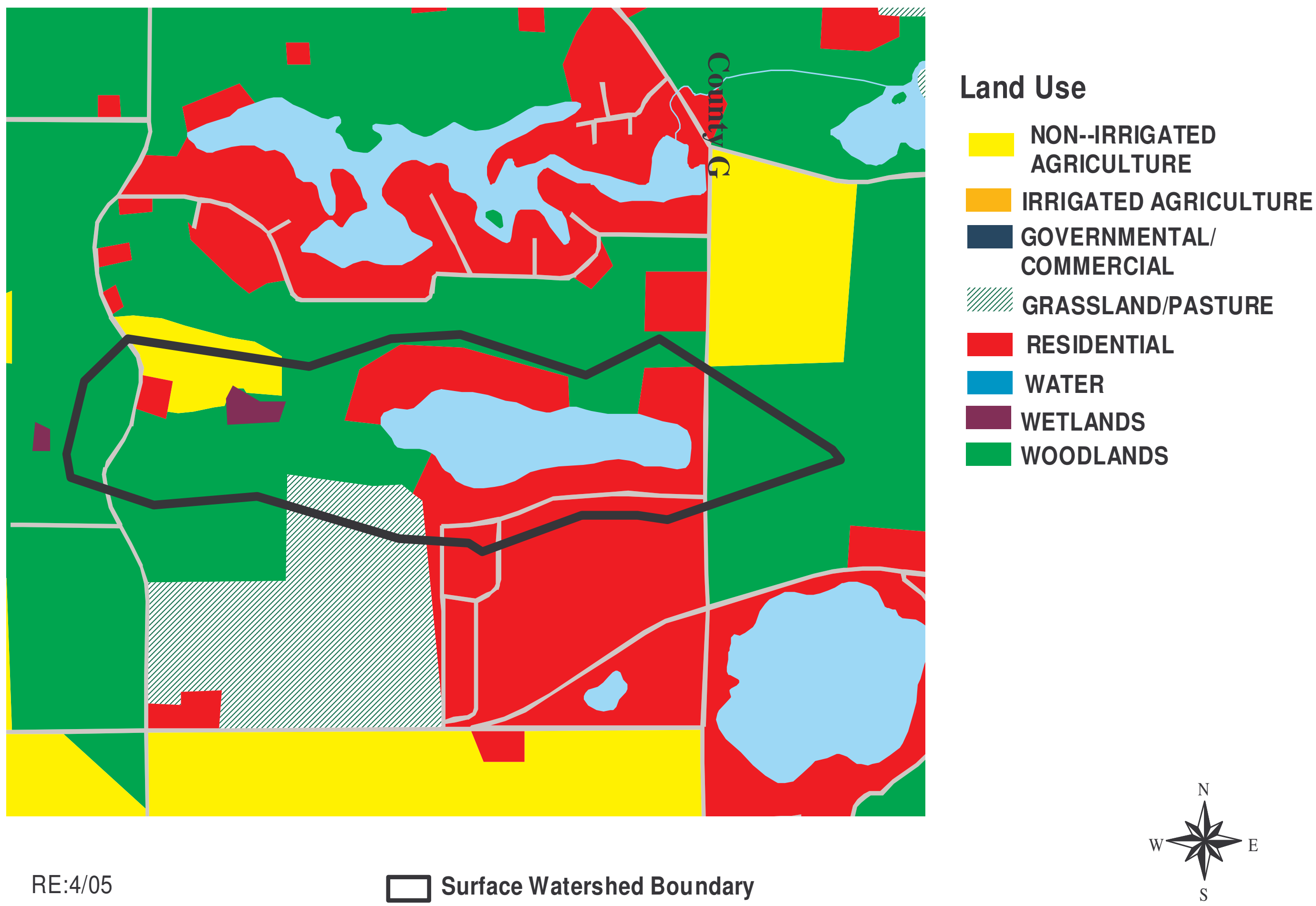
Both the surface and ground watersheds of Deep Lake are fairly small, as seen in the map and table below. The most common current land use in the Deep Lake Surface Watershed was woodlands. In the ground watershed, woodlands also dominate, although non-irrigated agriculture is also substantial (See Figures 5, 6a, 6b, 7a & 7b).

Figure 5: Deep Lake Watersheds Land Use in Acres and Percent of Total

	Surface		Ground		Total	
Deep Lake						
Agriculture--Non Irrigated	7.61	5.64%	31.38	4.36%	38.99	4.56%
Agriculture--Irrigated	0	0.00%	218.29	30.33%	218.29	25.54%
Government	0	0.00%	59.23	8.23%	59.23	6.93%
Grassland/Pasture	7.61	5.64%	10.72	1.49%	18.33	2.14%
Residential	19.81	14.68%	101.91	14.16%	121.72	14.24%
Water	35	25.93%	3.8	0.53%	38.8	4.54%
Woodland	64.93	48.11%	294.37	40.90%	359.3	42.05%
total	134.96	100.00%	719.7	100.00%	854.66	100.00%

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5" out of a 4" rainfall, leaving only .5" as runoff, a residential area with quarter-acre lots may absorb only 2.3" of the 4", leaving 1.7" to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7" of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230).

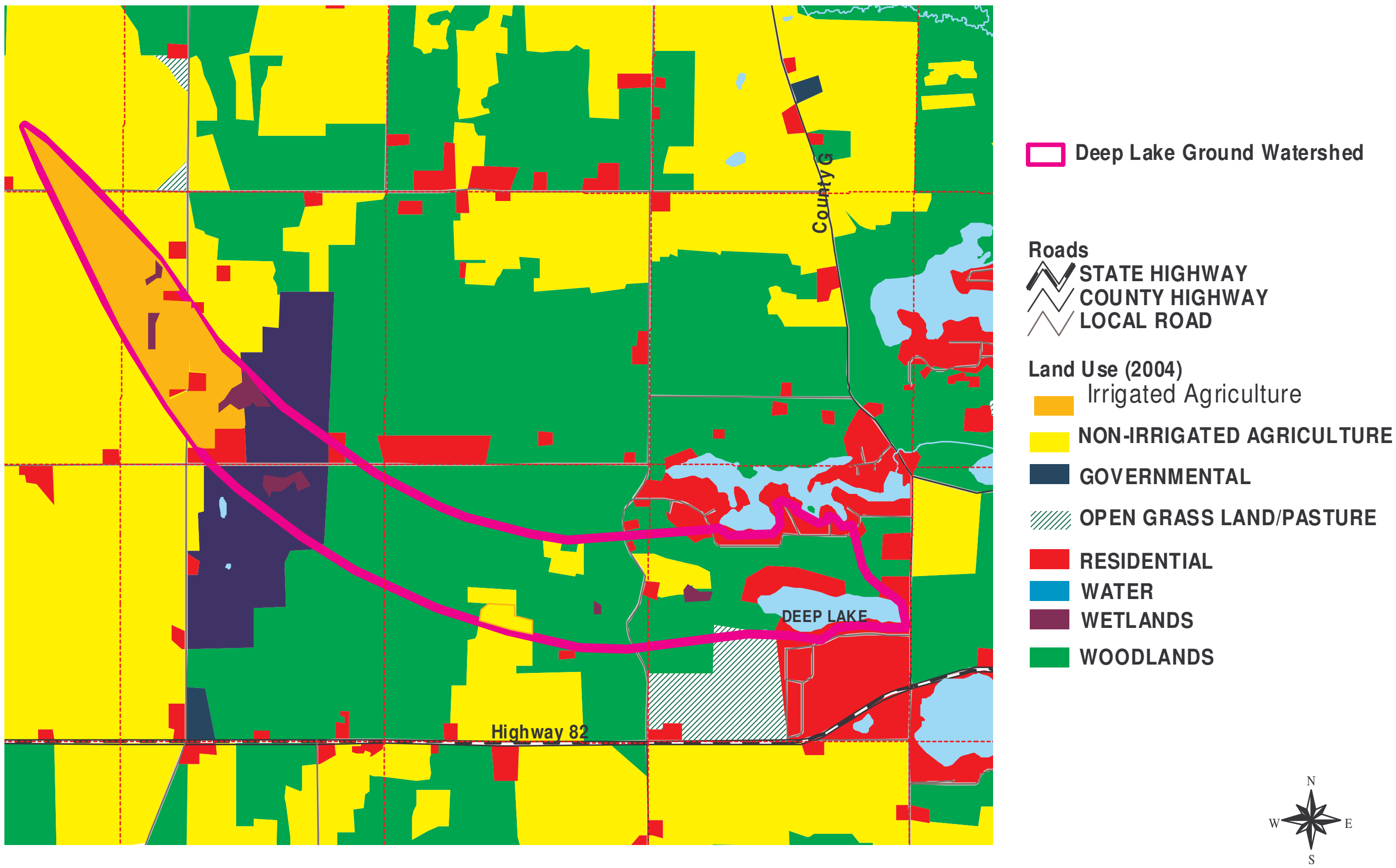
Land Use--Deep Lake Surface Watershed



RE:4/05

Figure 6a: Land Use in Deep Lake Surface Watershed

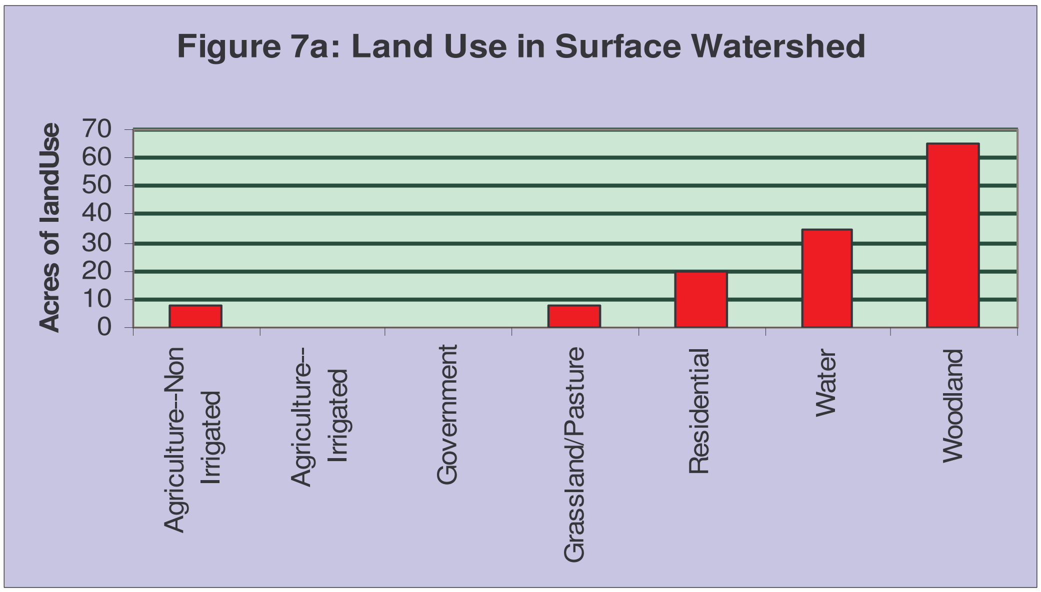
DEEP LAKE GROUND WATERSHED LAND USE

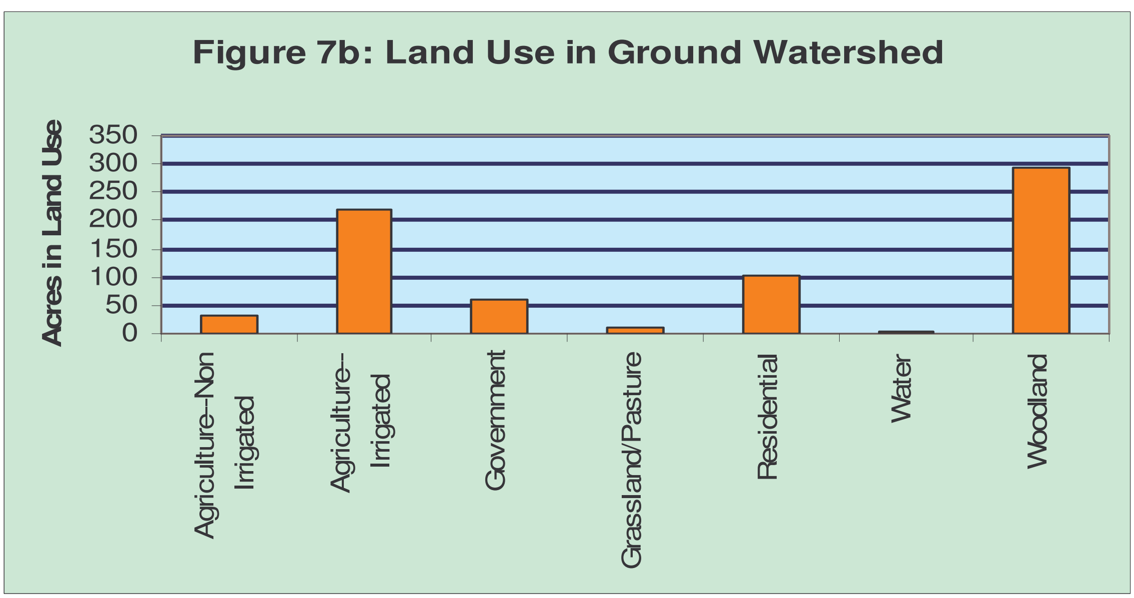


RE:2/05

Figure 6b: Land use in Deep Lake Ground Watershed

When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There is one specific kind of land use—shorelands—that is so important to water quality that it will be separately discussed.

SHORELANDS

Deep Lake has a total shoreline of 1.28 miles (6758 feet). Most of the shore has been left unaltered so far, except for a small beach associated with a campground, a few grassy areas by docks, and the east end of the lake, where riprap covers the front of five small resort cottages. Most of the areas near the shore are steeply sloped, except at the far east end, where the land is flatter directly by the shore. Buildings are generally located 70 or more feet back from the shore, except at the far east end where there are six buildings built very close to the water's edge.

The Adams County Land & Water Conservation Department conducted a survey of the Deep Lake shoreline in 2004. Shore types were categorized as "armored" and "vegetated". "Vegetated" shores encompassed both native vegetation of any type and mowed lawns. 78.83% (5327.4 feet) of Deep Lake's shoreline is vegetated (this includes mowed lawns). 15.17% (1025.55 feet) is armored. The remaining 6% (404.45 feet) is actively eroding.

Figure 8: Deep Lake Shores

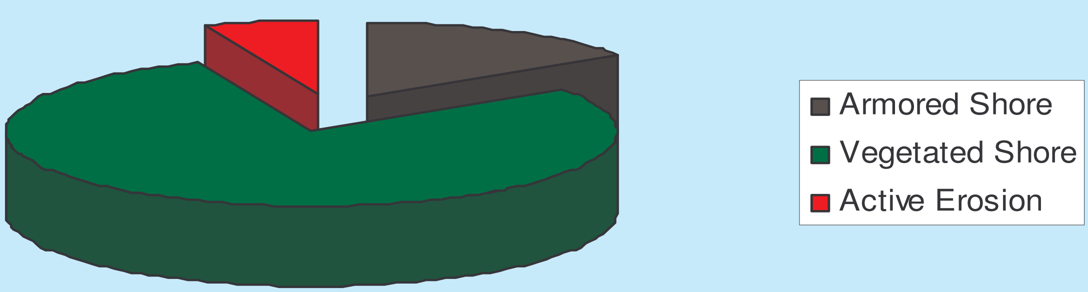
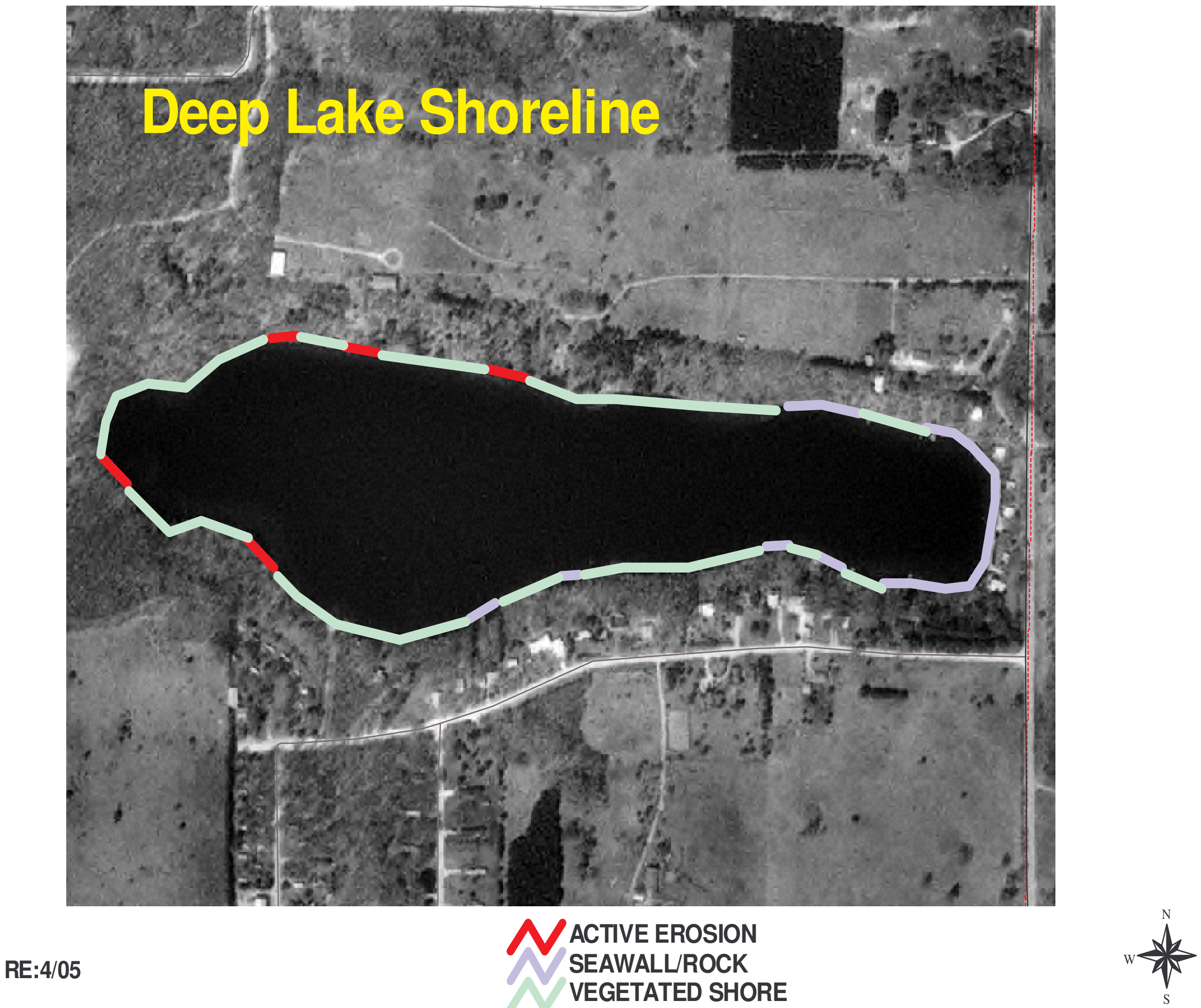
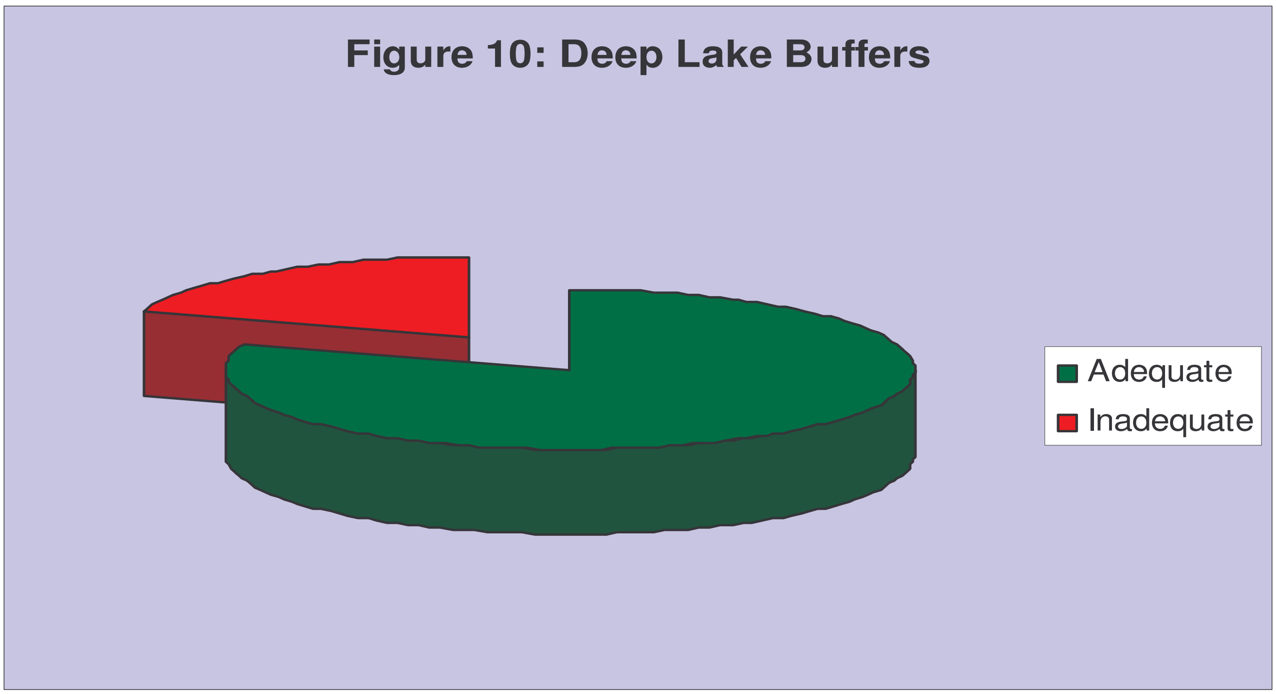


Figure 9: Shoreline of Deep Lake (2004)



Under the Adams County Shoreland Ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

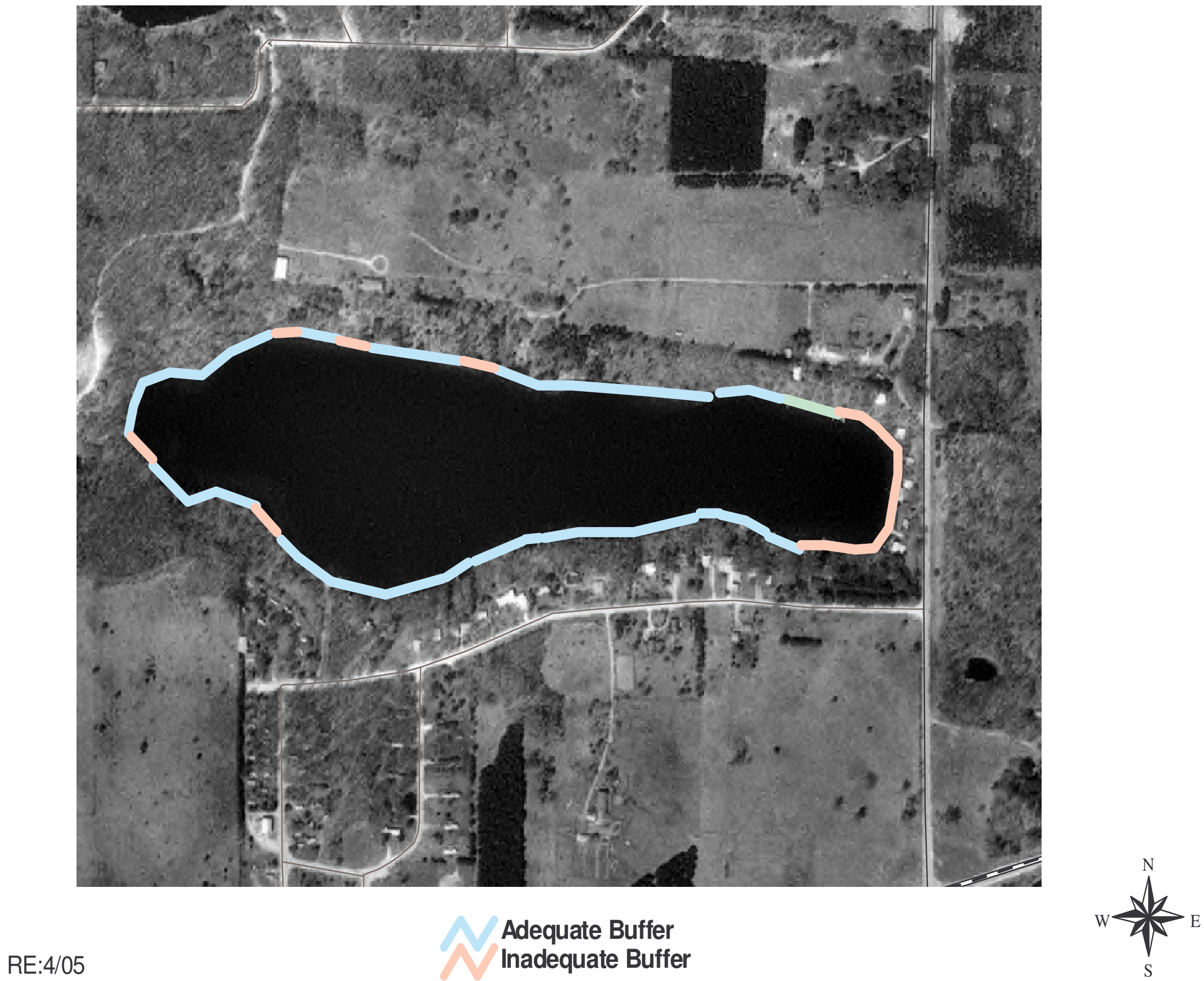
The 2004 inventory included also classified Deep Lake shorelines as having "adequate" or "inadequate" buffers. An "adequate" buffer was defined as one having the first 35 feet landward covered by native vegetation. An "inadequate" buffer was anything that didn't meet the definition of "adequate buffer", including native vegetation strips less than 35 feet landward. The shore survey showed that more than 80% of the shore had an "adequate buffer." However, some 20% of the shore had an "inadequate buffer". Most of the "inadequate" buffer areas were those with hard structures, mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line or had active erosion occurring.



Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are many of the Deep Lake shores. Figure 11 maps the adequate and inadequate buffers on Deep Lake.

Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

Figure 11: Buffer Categories on Deep Lake



When the natural shoreline is replaced by traditional mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils would be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Figure 12a: Example of Inadequate Buffer

Figure 12b: Example of Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesethics. Studies have shown that aeshetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on Deep Lake could be easily installed on most of the lake by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or—if something more controlled or aesthetically pleasing was desired—by planting native seedlings sufficient to fill in the first 35 feet. At the far east end, due to the buildings so close to the water, the rock riprap would need to be removed and buffers and stormwater runoff practices installed to keep pollution from those areas from ending up in the lake.

Figure 13: Photo of East End of Deep Lake Showing Buildings Close to Shore

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Deep Lake. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on Deep Lake was also obtained from the WDNR (1992).

Phosphorus

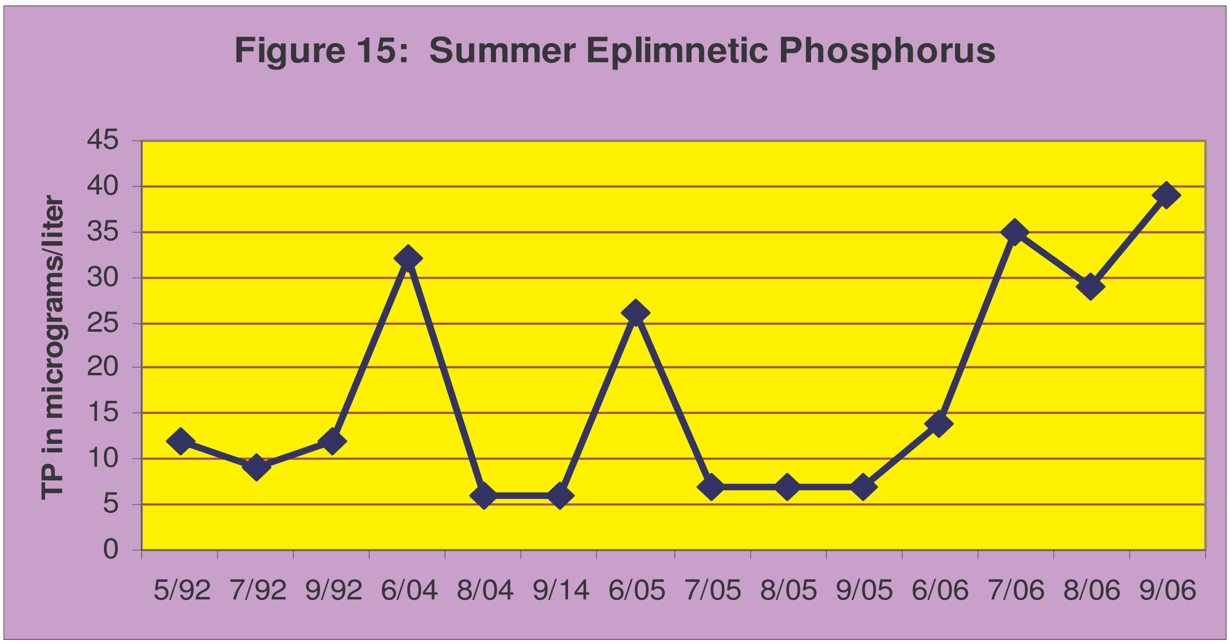
Most lakes in Wisconsin, including Deep Lake, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted) or hypoxic (low oxygen), chemical reactions may cause phosphorus to be released into the water column.

Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a natural lake like Deep Lake, a total phosphorus concentration below 25 micrograms/liter tends to reduce nuisance algal blooms. Since Deep Lake's growing season (June-September) surface average total phosphorus level micrograms/liter is lower than that figure, nuisance algal blooms should occur only rarely.

Since the limiting factor is usually phosphorus, measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Deep Lake was 17.92 micrograms/liter. This is below the 25 micrograms/liter average for natural lakes in

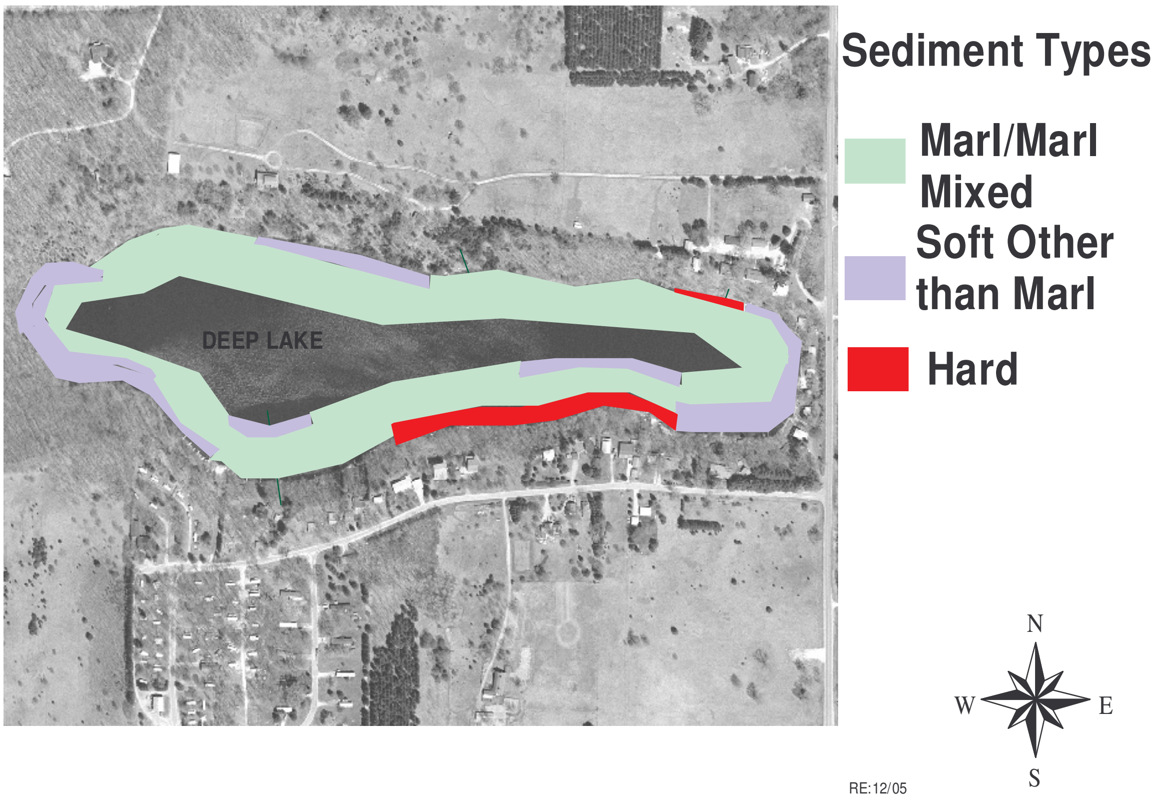
Wisconsin. This concentration suggests that Deep Lake is likely to have few nuisance algal blooms. This places Deep Lake in the “good” level for phosphorus.



However, a comparison of the average summer phosphorus level in the lower depths of Deep Lake (35’ and deeper) to the upper depths (surface) shows that phosphorus concentrations in the lower levels of Deep Lake are 170% higher in the growing season than those from the upper layers of water. This suggests that the lower water depths may be accumulating phosphorus, added to that accumulating in the sediments. This situation should be monitored

As the above graph (Figure 15) indicates, the recent growing season total phosphorus levels have varied, but stayed below the 25 micrograms/milliliter recommended to avoid nuisance algal blooms, except in 2006, which had a very hot dry summer. Still, considering that the overall line since 1997 has been showing mostly increased total phosphorus levels for the growing season, phosphorus should continue to be monitored.

Figure 16: Deep Lake Sediment Map



In most lakes in Wisconsin, phosphorus concentration in the bottom sediments of the lake is considerably higher than the concentration in the water column itself. Bottom sediments can "bind up" phosphorus, making it unavailable for aquatic plants or algae to use. Some sediment types hold phosphorus at a higher rate than others.

As can be seen on the sediment map (Figure 16), much of the bottom of Deep Lake is marl sediment. "Marl" is a calcium carbonate precipitate (solid) that forms in hardwater lakes when both calcium and pH levels are high. Marl can be good for a lake because it has a high capacity to bind phosphorus, as well as other nutrients. With such a large amount of marl sediment, Deep Lake may benefit from it removing phosphorus from water column, thus making it unavailable for algal and aquatic plant growth.

How much a marl sediment affects aquatic plant and algal growth will depend on where the marl sediment is located, i.e., if the aquatic plants are rooted in the marl, so that they can still draw phosphorus from it, the presence of marl may not reduce aquatic plant growth. Effect will also depend on how much phosphorus the marl has already absorbed. In 80% of Wisconsin's lakes, phosphorus is the key nutrient that determines the amount of algae and aquatic plant growth. Since much of the marl in Deep Lake is in the deeper areas of the lake, the marl sediment probably offers more protection against nuisance algal growth than aquatic plant growth.

Groundwater testing of various wells around Deep Lake was done by Adams County LWCD and included a test one year (2006) for total phosphorus levels in the groundwater coming into the lake. The average TP level in the wells tested was 12 micrograms/liter, somewhat lower than the lake surface water results. This phosphorus may also seep into Deep Lake, although if the level is always that low, it wouldn't be a significant contributor of phosphorus.

Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. The land uses that contribute the most phosphorus are non-irrigated agriculture and residences. Using the current land use data, as well as phosphorus readings from 2004 through 2006, a phosphorus loading prediction model was run for Deep Lake. The current results are shown in the table below:

Figure 17: Most Likely Current Phosphorus Loading

MOST LIKELY LOADING		Current
BY LAND USE	%	lb/yr
Agriculture--Non Irrigated	5.8%	6.60
Agriculture--Irrigated	23.2%	26.40
Grassland/Pasture	0.7%	0.50
Residential	7.9%	8.80
Woodlands	2.5%	2.20
Groundshed	27.6%	33.00
Lake Surface	4.0%	4.40
Septics	28.3%	32.87
Total in pounds/year	100.0%	114.77

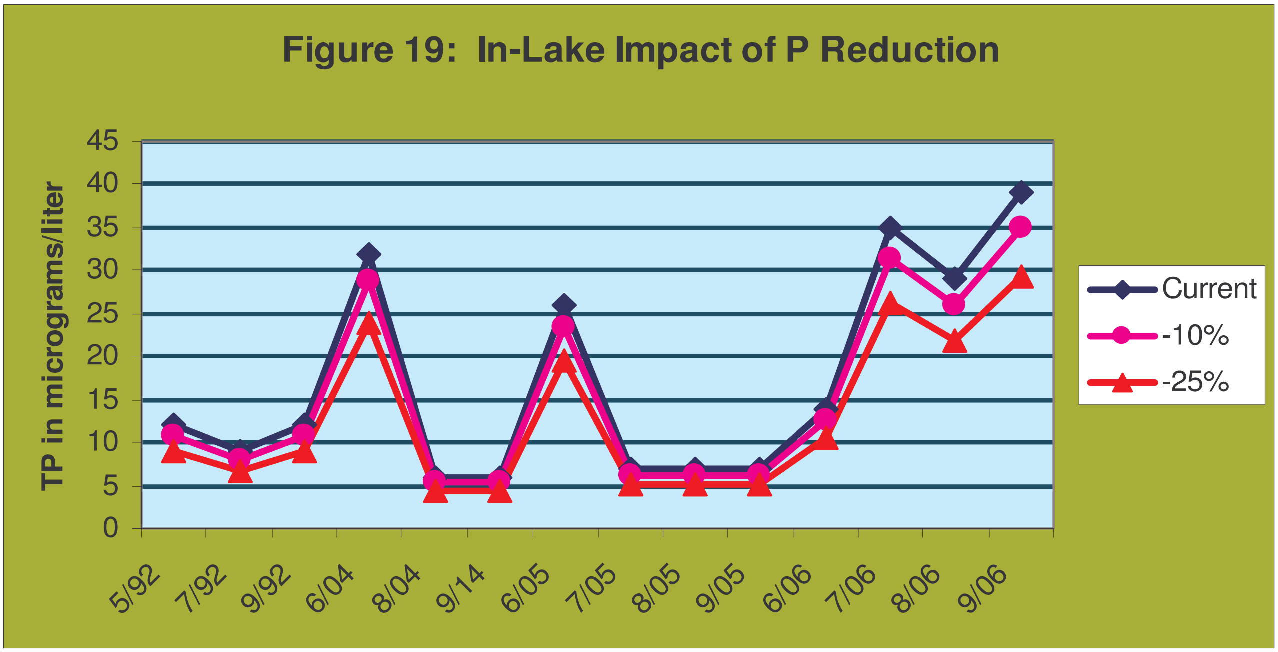
Phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the volume of phosphorus entering the lake. Many of these practices can also increase the concentration of phosphorus entering the lake, by runoff or other methods of entry.

The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. The figures may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in 5385 pounds less of algae per year!

Figure 18: Impact of Phosphorus Reduction

Land Use	-10%	-25%	-50%
Agriculture--Non Irrigated	5.94	4.95	3.30
Agriculture--Irrigated	23.76	19.80	13.20
Grassland/Pasture	0.50	0.50	0.50
Residential	7.92	6.60	4.40
Woodlands	2.20	2.20	2.20
Groundshed	29.70	24.75	16.50
Lake Surface	4.40	4.40	4.40
Septics	29.58	24.65	16.43
Total in pounds/year	104.00	87.85	60.93

Looking at this issue in terms of how much phosphorus readings in the lake might change, based on the computer modeling, in-lake perhaps makes it clearer. Figure 17 shows that the effect of 10% and 25% decrease to human-impacted phosphorus within the lake.



Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Deep Lake water quality by .7 to 3.9 micrograms of phosphorus/liter; a 25% reduction would save 1.5 to 9.75 micrograms/liter (see Figure 19). The 25% reduction would put nearly all the phosphorus levels in the lake under the threshold in the summer.

These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Deep Lake's health for future generations. This will become even more important if a larger part of the shore is developed, especially if the east end, where buildings are very close to the water, is changed in impervious surface or footprint.

Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Deep Lake in 2004-2006 was 12.96 feet. This is very good water clarity, putting Deep Lake into the "oligotrophic" category for water clarity. If the readings taken in 1992 are added into the overall calculation, the average Secchi disk reading in the summers for Deep Lake is 12.71 feet (see Figure 20).

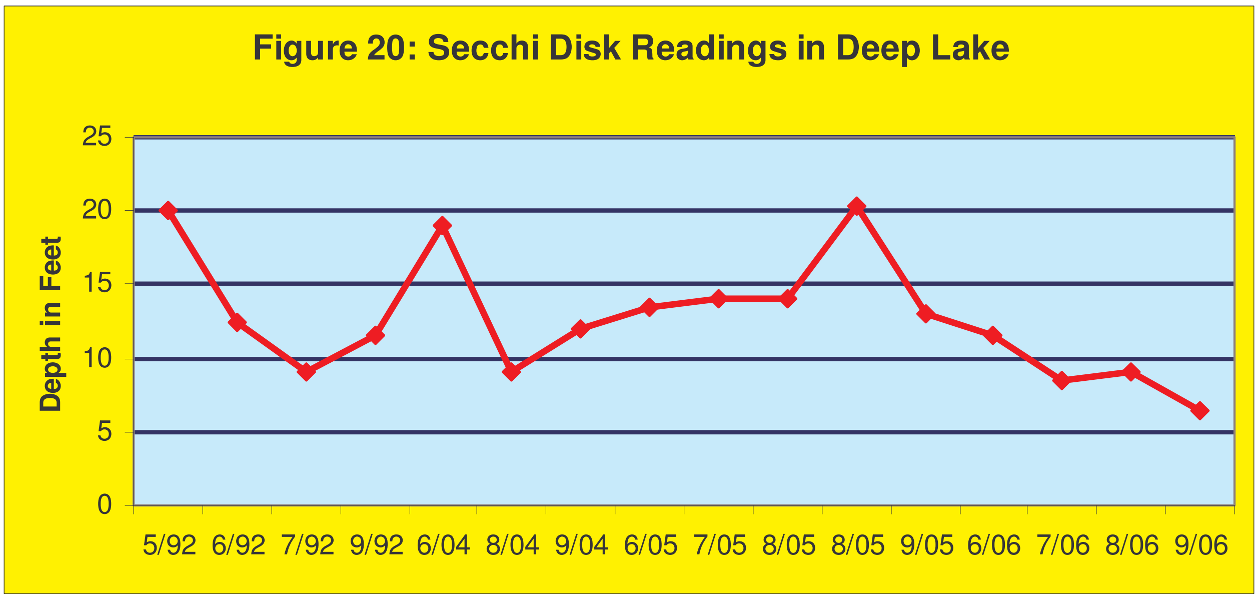
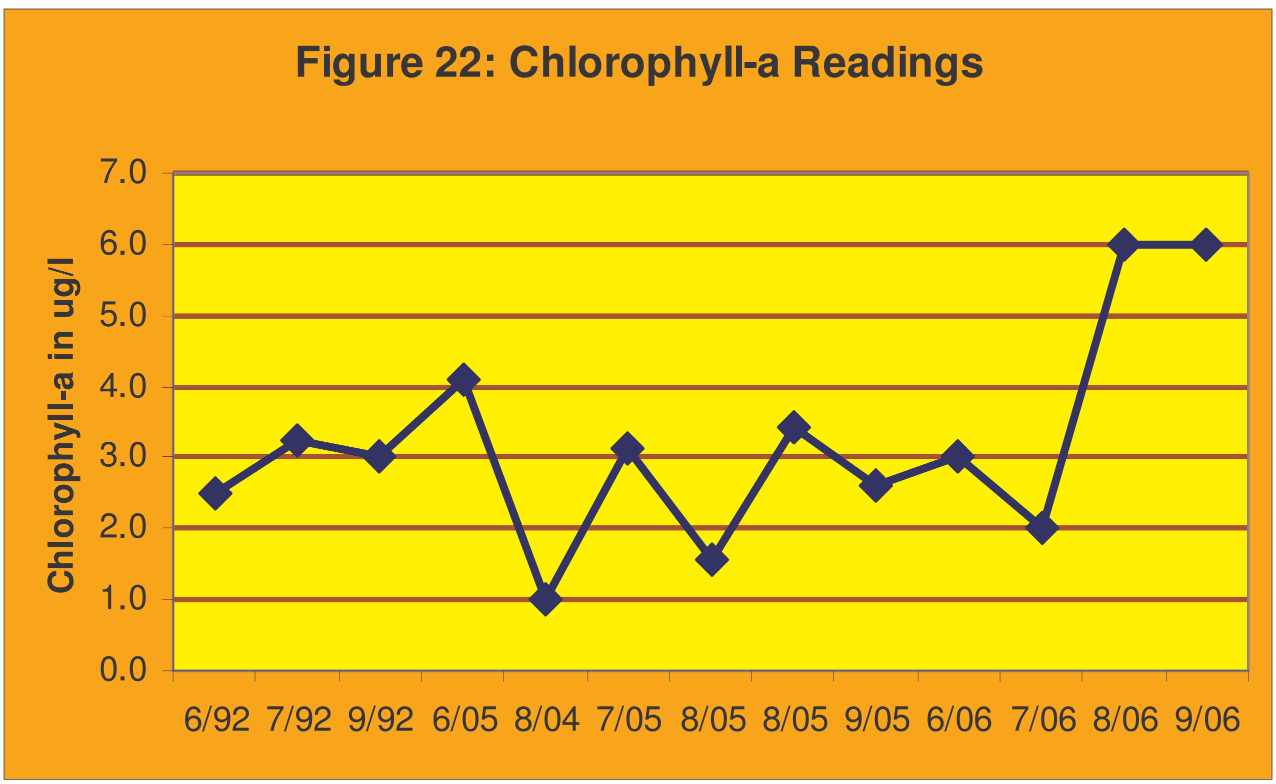


Figure 21: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 summer (June-September) average chlorophyll concentration in Deep Lake was 3.6 micrograms/liter This low algae concentration places Deep Lake at the "oligotrophic" level for chlorophyll a results.

The chlorophyll-a average for summer of 1992 was 2.81 milligrams/liter, the first only other year for which information is available. The chlorophyll-a average has remained low for the last fifteen years.

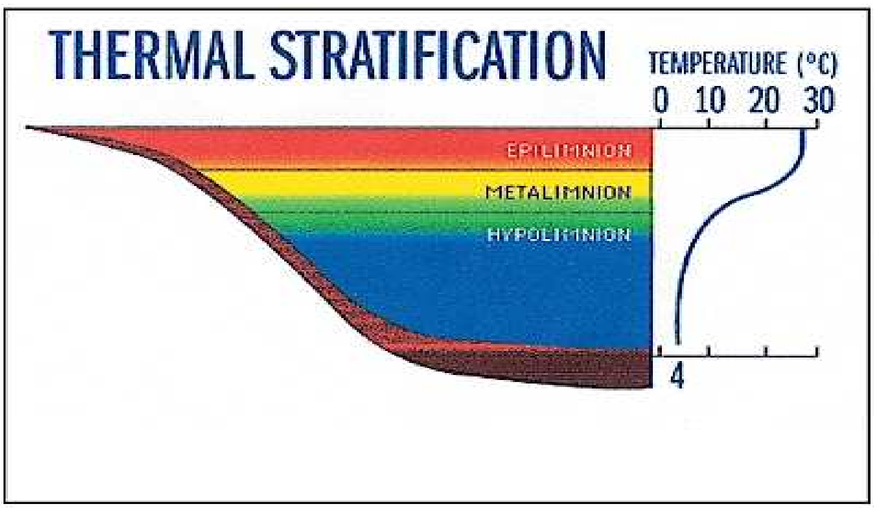


Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants.

Oxygen consumption in the sediment and the water just above it (hypolimnion) is more sensitive that those in the two upper layers of water (metalimnion and epilimnion) because the bottom consumption is less likely to be balanced by the circulation and photosynthesis output available to the upper layers.

Figure 23: Lake Stratification Layers



Low oxygen during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. It is common that as the summer progresses, the oxygen concentration of the bottom waters decreases. In Deep Lake, there were hypoxic periods in the depths from 25’ to 50’ during the summers of 2004.2005 and 2006. By end of summer 2004 (September), dissolved oxygen concentration at 25’ depth was only 1.8 mg/l and lower in deeper water. And in 2005, by September, dissolved oxygen concentration at 25’ down was only 1.05 mg/l. This pattern was not as drastic in 2006, but there was one hypoxic reading of 0.58 mg/l in August 2006 (with July and September both being over 5 mg/l).

The charts (Figures 24 a, b, c) below show the annual (2004-2006) variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the year:

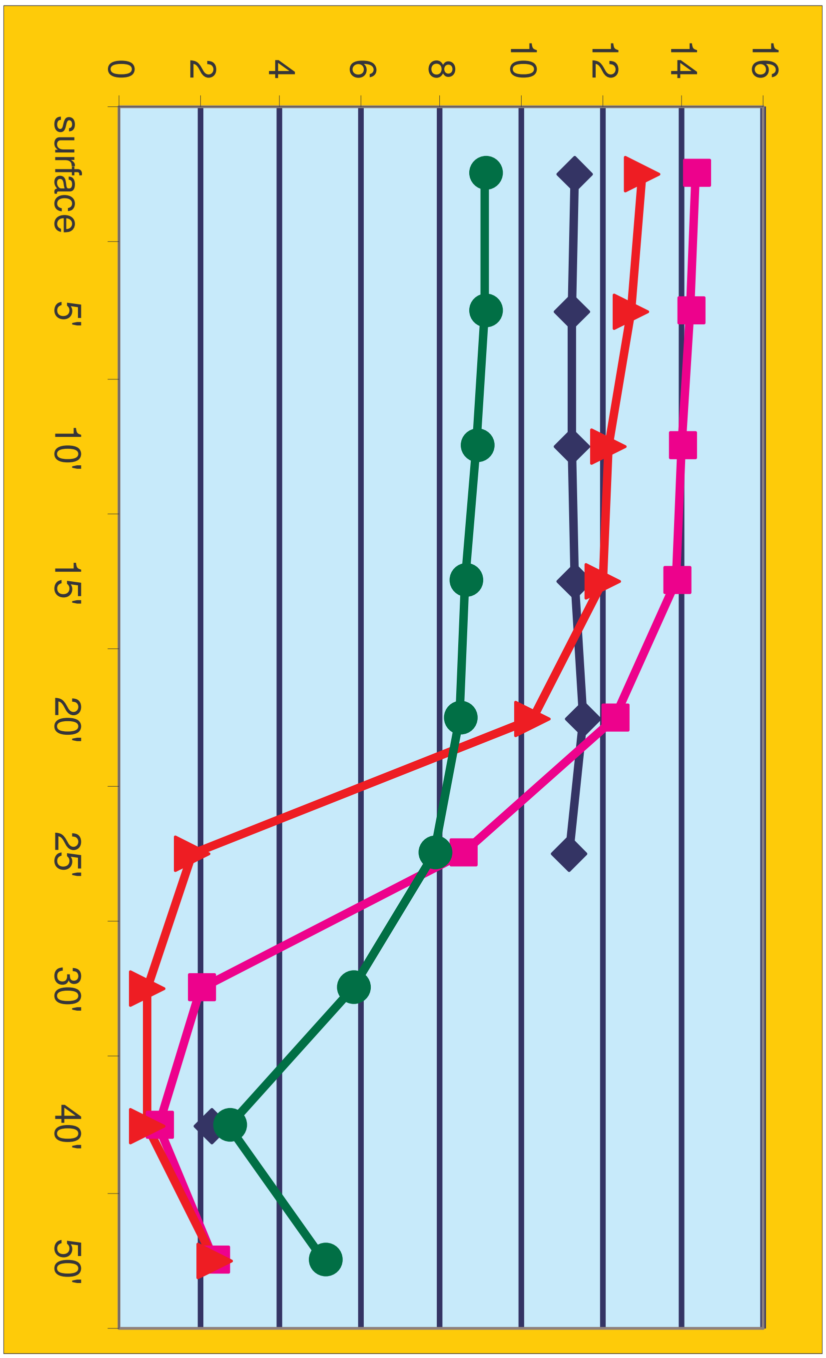


Figure 24a: Dissolved Oxygen Levels During 2004 Water Testing in milligrams/liter

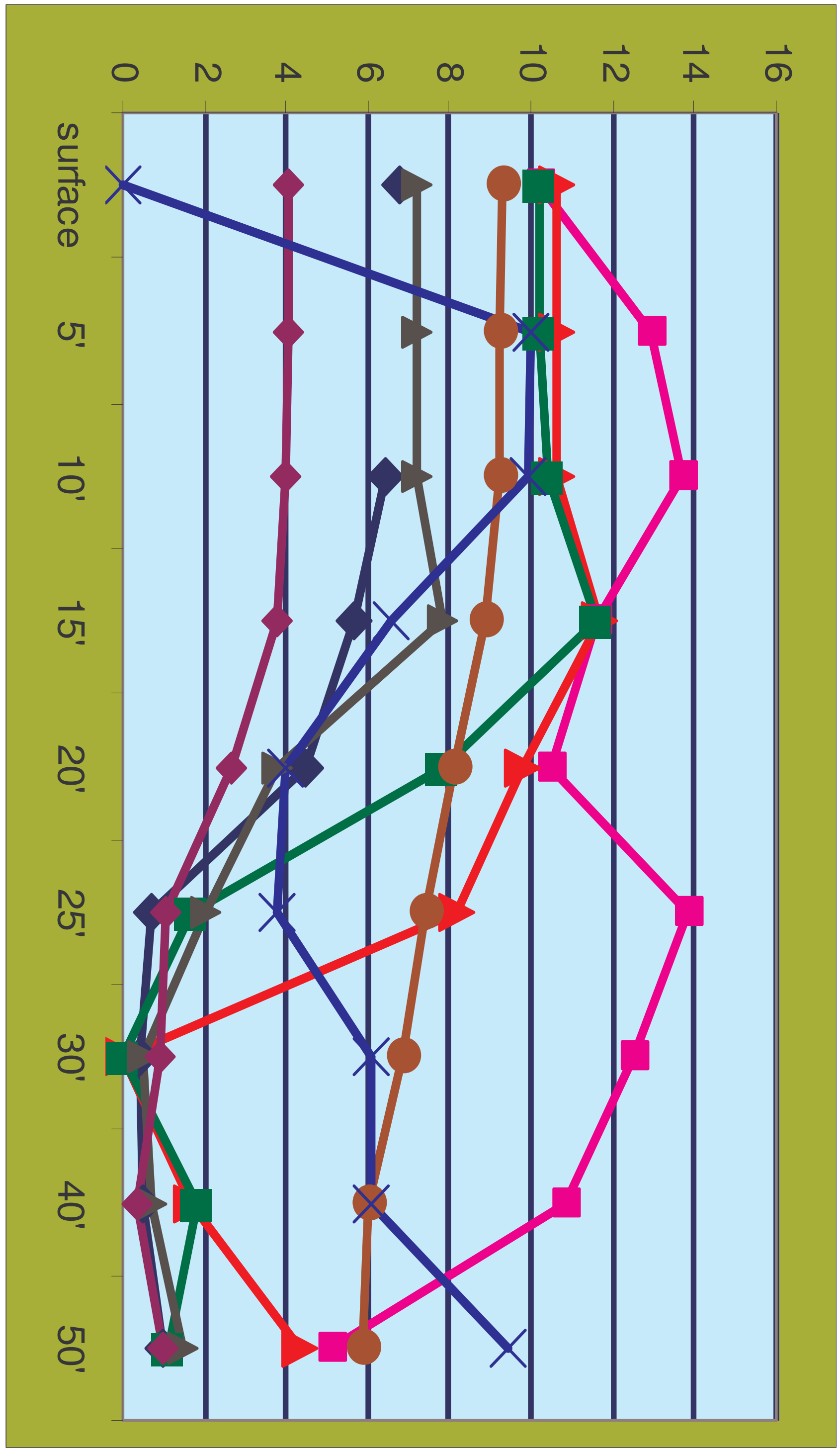
6/04

8/04

9/04

11/04

Figure 24b: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter



2/05

4/05

6/05

7/05

8/05

9/05

9/05

11/05

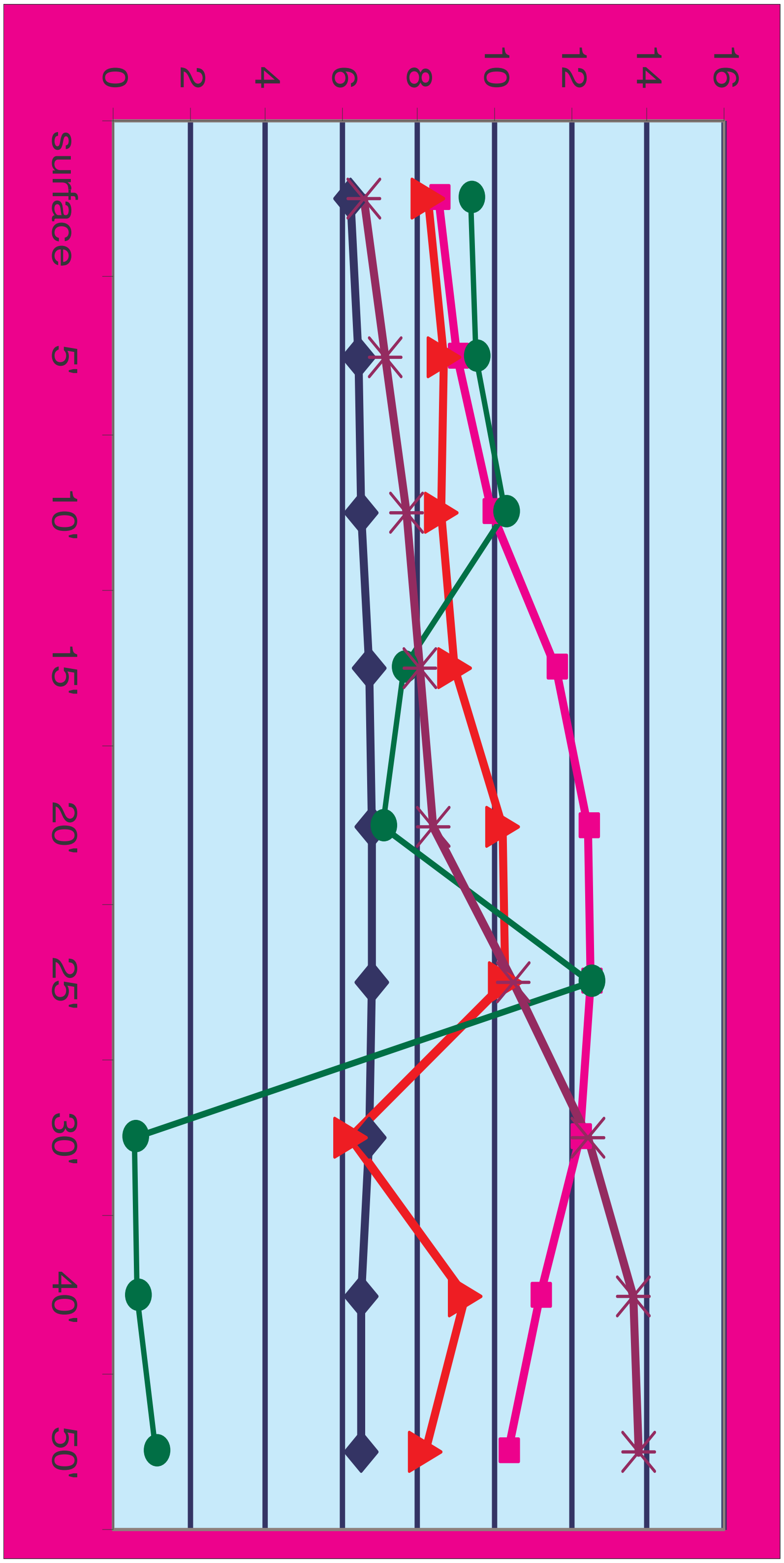


Figure24c: Dissolved Oxygen Levels During 2006 Water Testing in milligrams/liter

4/06

6/06

7/06

8/06

9/06

By autumn, when the surface waters have cooled and water density throughout the water column is the same, the water column mixes vertically, a process known as "fall turnover."

Human activity can aggravate the development of low oxygen (hypoxic) or no oxygen (anoxic) in the bottom waters. For example, the addition of phosphorus usually leads to an increase in the growth of algae and aquatic plants—both of which consume oxygen during their photosynthesis. It has also been hypothesized that hypoxia or anoxia can be affected by climate changes, such as a longer and/or warmer summer, low lake levels, and changes in water temperature due to cover (i.e., shore vegetation) being removed.

The development of hypoxia or anoxia can have negative effects. The first effect usually noticed by human is fish kills. Fish kills result when fish species that need cold oxygen-rich water to survive can't find it in the lake anymore or when some of their invertebrate food (such as mayfly nymphs) is gone due to low oxygen levels. Another noticeable effect can be an increase in the frequency and distribution of algal blooms. In some instances, anoxia can lead to blooms of toxic algae and the production of water-borne toxins that can harm humans and wildlife. Anoxia sometimes also leads to increased phosphorus cycling, undesirable water taste or odor levels, and interference with recreational uses such as swimming, boating and fishing.

As noted above, summer hypoxia or anoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. All three summers from 2004 through 2006 (the only years for which data is available) had some summer hypoxia/anoxia in the lower depths.

The data from 2004-2006 (see Figures 24a, b, c) shows there is potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in Deep Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on Deep Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

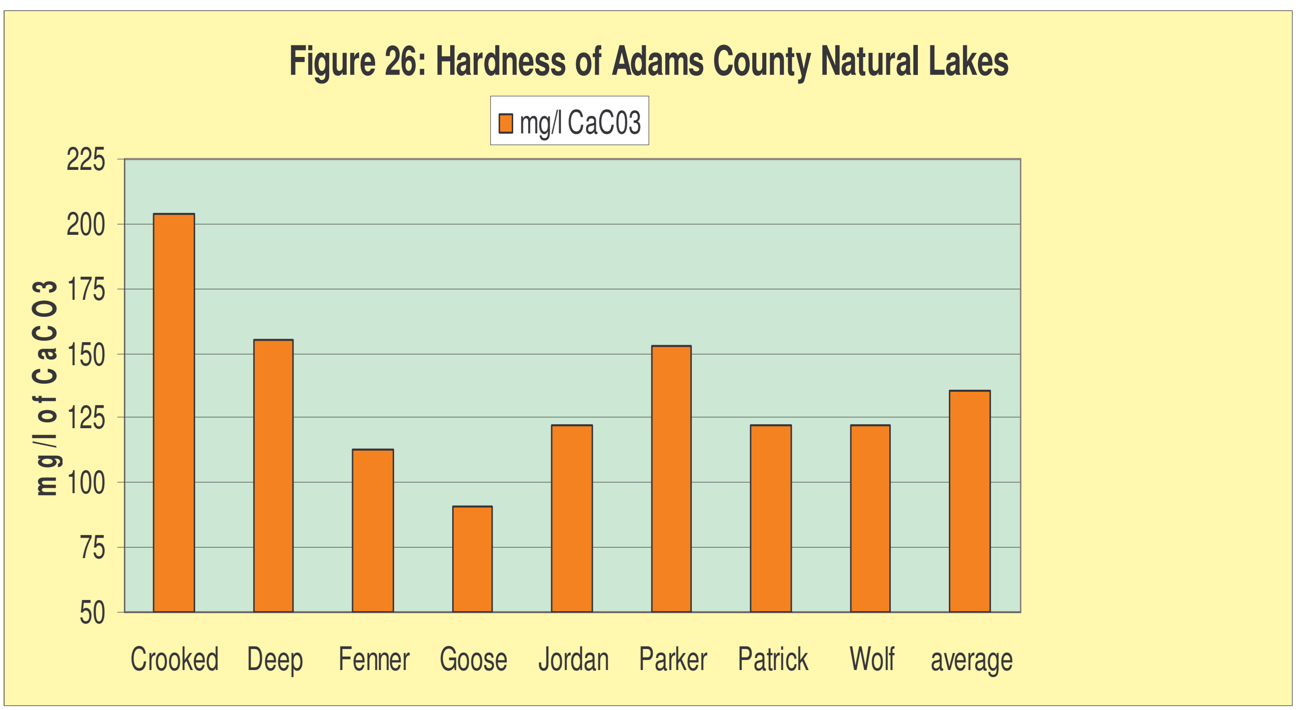
Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Deep Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Mg/l CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 25: Levels of Hardness in Mg/l of Calcium Carbonate

One method of evaluating hardness is to test the water for the amount of calcium carbonate (CaCO3) it contains. The surface water of all of the public access lakes in Adams County is moderately hard to very hard. In 2005 and 2006, random samples were also taken of wells around Deep Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater ranged from 152 mg/l (hard) to 276 mg/l (very hard), for an average of 214.4 mg/l. Surface water hardness was 155 mg/l. The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.



As the graph (Figure 26) shows, Deep Lake surface water testing results showed "hard" water" (over 155 mg/l of CaCO3), which is a higher hardness than the average for Adams County's natural lakes (135 mg/l of Calcium Carbonate). Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

However, hard water lakes also often have marl sediments that precipitate the phosphorus out, serving to help balance the phosphorus loaded from the watershed. Hardness levels over 180 mg/l can cause marl to start precipitating out of the water or sediment, thus releasing phosphorus for aquatic plant and algae use. Since Deep Lake's hardness less is above that number, the marl sediments in the lake may release phosphorus into in the water column.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

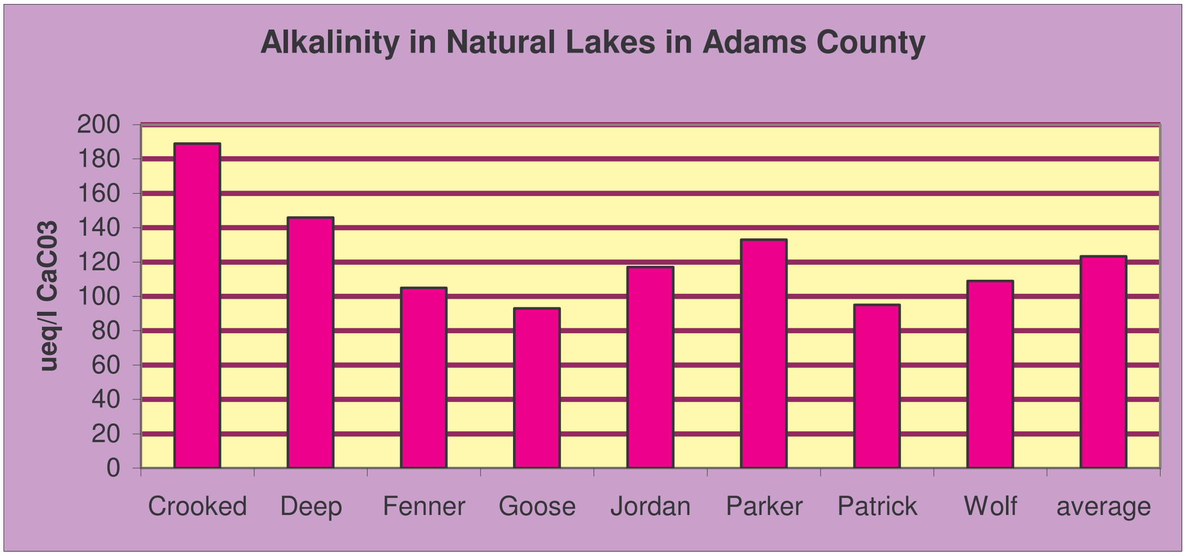
Figure 27: Acid Rain Sensitivity

Well water testing results ranged from 160 ueq/l to304 ueq/l in alkalinity, with an average of 235.43 ueq/l. The surface water average alkalinity was 145.6 ueq/l, considerably lower than the ground water results. Deep Lake's potential sensitivity to acid rain is low to moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

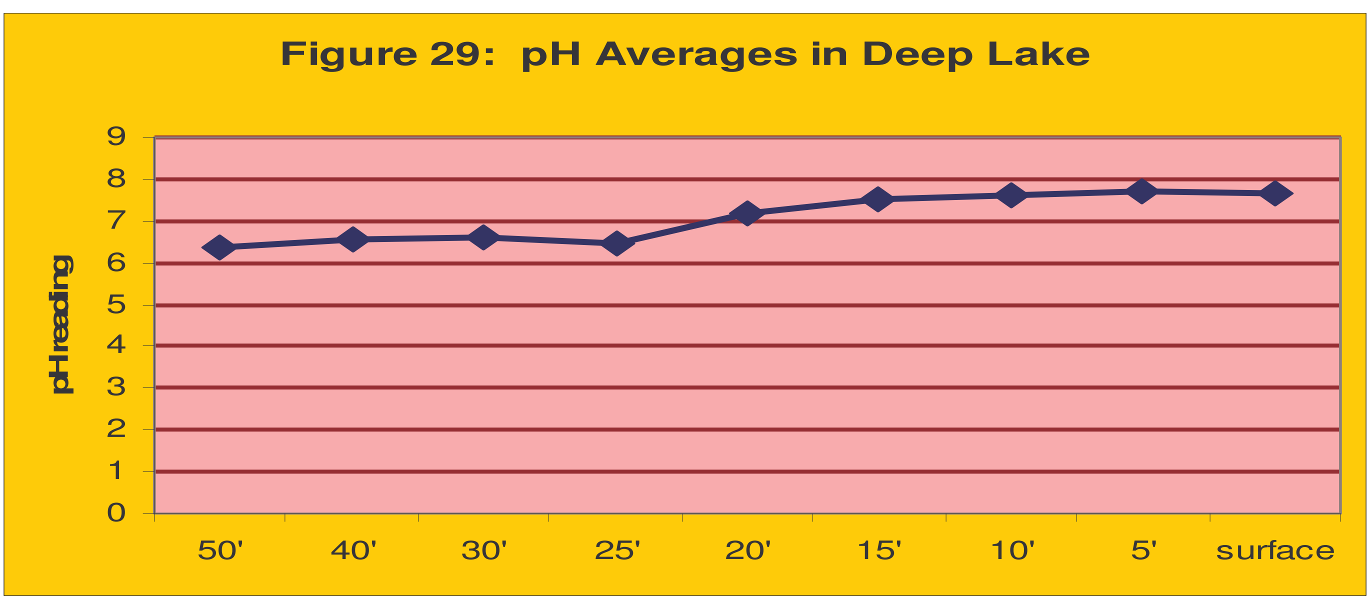
Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.

Figure 28: Alkalinity in Natural Lakes in Adams County



The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Deep Lake. As is common in the lakes in Adams County, Deep Lake has pH levels starting at just under neutral (6.39) at 50' depth and increasing in alkalinity as the depth gets less, until the surface water pH averages 7.67. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.



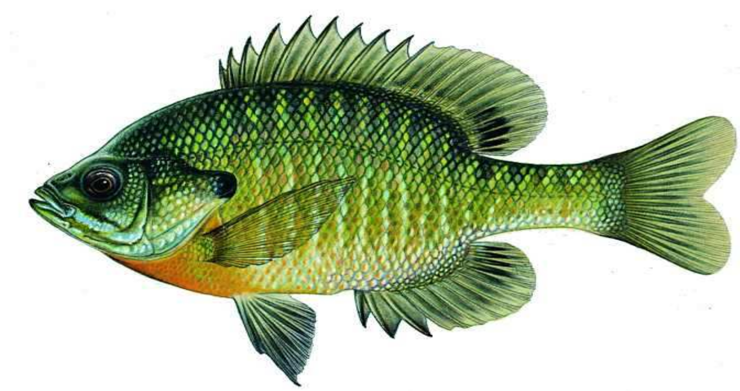
More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 30):

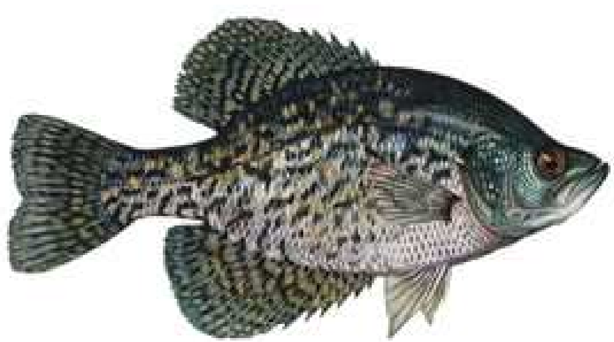
Figure 30: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

A lake with a neutral or slightly alkaline pH like Deep Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Deep Lake.

Figure 31: Common Fish in Deep Lake: Bluegill (right) and Crappie (bottom)





Other Water Quality Testing Results

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 mg/l may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from these elements. The average Calcium level in Deep Lake's water during the testing period was 28.47 mg/l. The average Magnesium level was 19.32 mg/l. Both of these are low-level readings.

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus a possible indication that too many nutrients are entering the lake. The chloride levels found in Deep Lake during the testing period averaged 1.22 mg/l, well below the natural level of 3 mg/l of chloride in this area of Wisconsin.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Deep Lake combination nitrogen level from 2004 to 2006 was .09 mg/l, far below the .3 mg/l predictive level for algal blooms. Deep Lake is not likely to have nitrogen-related algal blooms with its level.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. Increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Both sodium and potassium levels in Deep Lake are low: the average sodium level was 1.89 mg/l; the average potassium reading was 1.03 mg/l.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, sulfate levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Deep Lake sulfate levels averaged 6.05 mg/l during the testing period, far below either level.

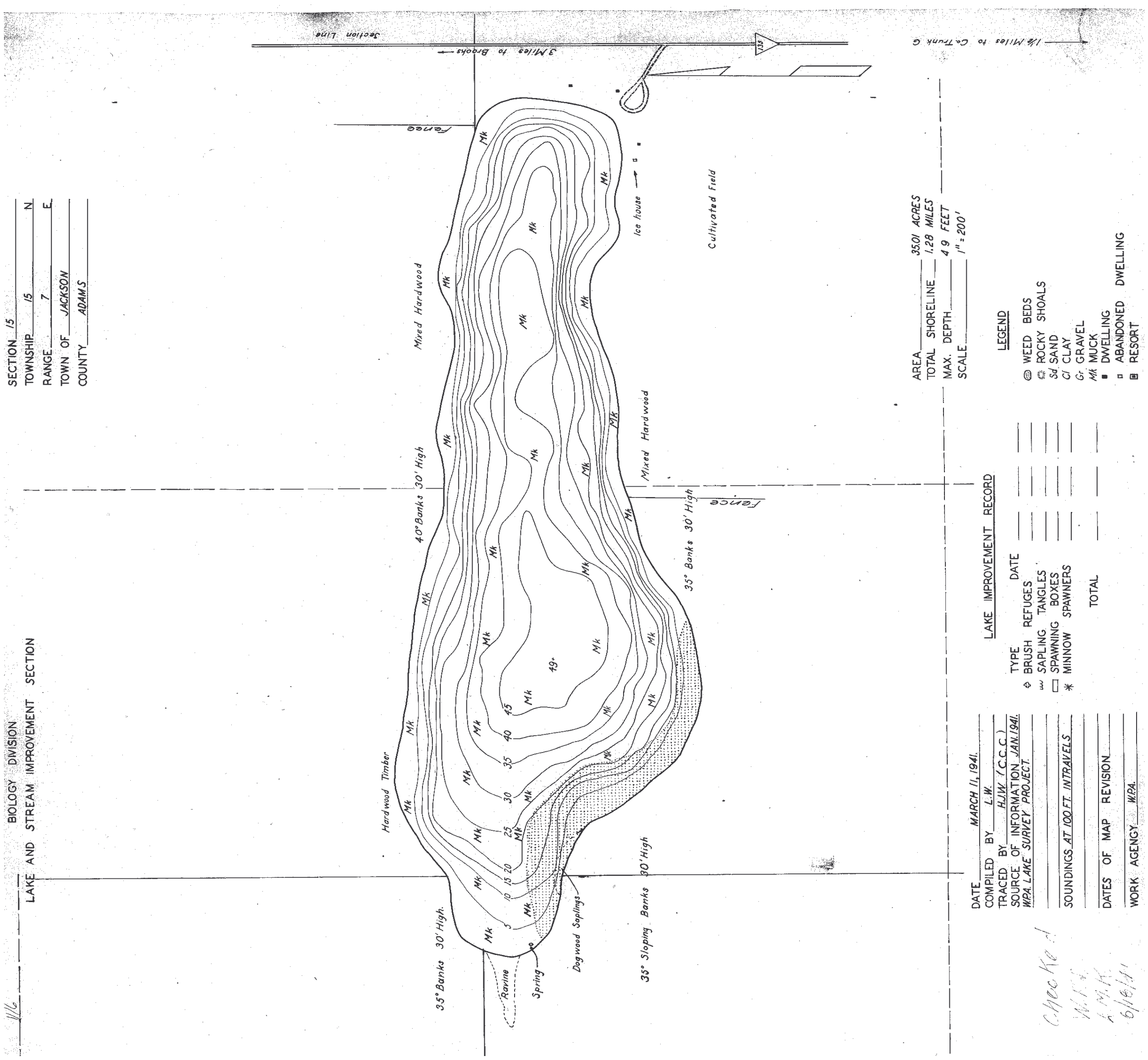
TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Deep Lake's waters were 2.36 NTU in 2004, 1.89 NTU in 2005, and 2.5 NTU in 2006—all low levels.

Figure 32: Examples of Very Turbid Water

HYDROLOGIC BUDGET

Deep Lake has a surface area of 35 acres. It has a maximum depth of 55 feet and a mean depth of 25 feet. Its bottom slopes steeply towards the middle. It has a volume of 875 acre-feet. The most recent bathymetric map available is from 1941 (Figure 33).

Figure 33: Deep Lake Bathymetric Map

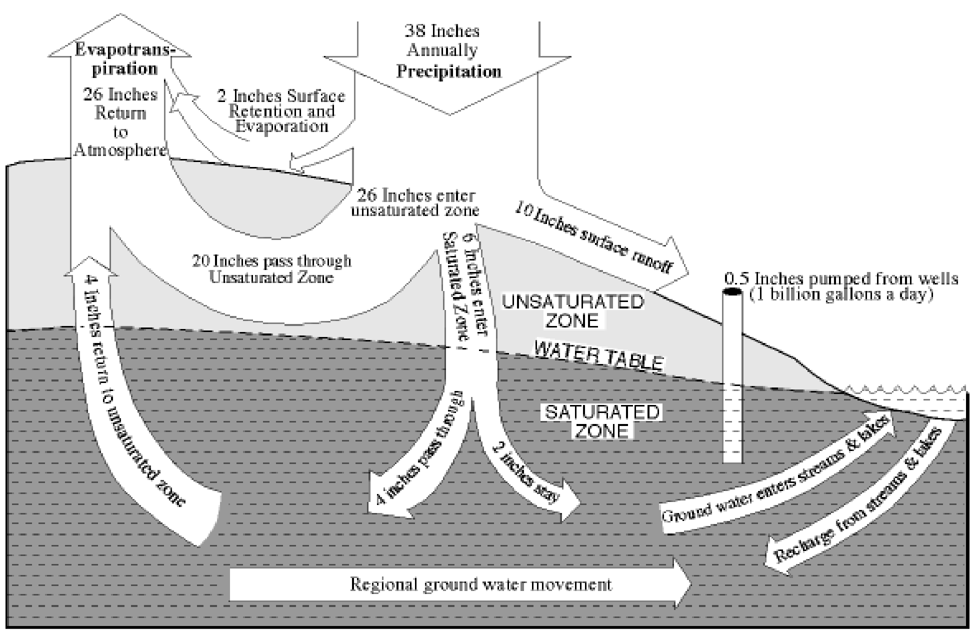


A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Flushing time" is the amount of time it takes to refill the lake. "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for Deep Lake as 1002.4 acres. The average unit runoff for Adams County in the Deep Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 785.2 acre-feet/year. Anticipated annual hydraulic loading is 792.8 acre-feet/year. Areal water load is 22.7 feet/year.

In a seepage lake like Deep Lake, water and its nutrient load tend to stay longer within the lake before leaving it than in a lake with an inlet and/or outlet—in Deep Lake's case, modeling estimates a water residence of 1.10 years. The flushing rate is 0.91 1/year.

Figure 34: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (See Figure 35). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of Deep Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Deep Lake would be **43**. This score places Deep Lake's overall TSI at about average for natural lakes in Adams County (43.9).

Figure 35: Trophic Status Table

Deep Lake = 43

Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

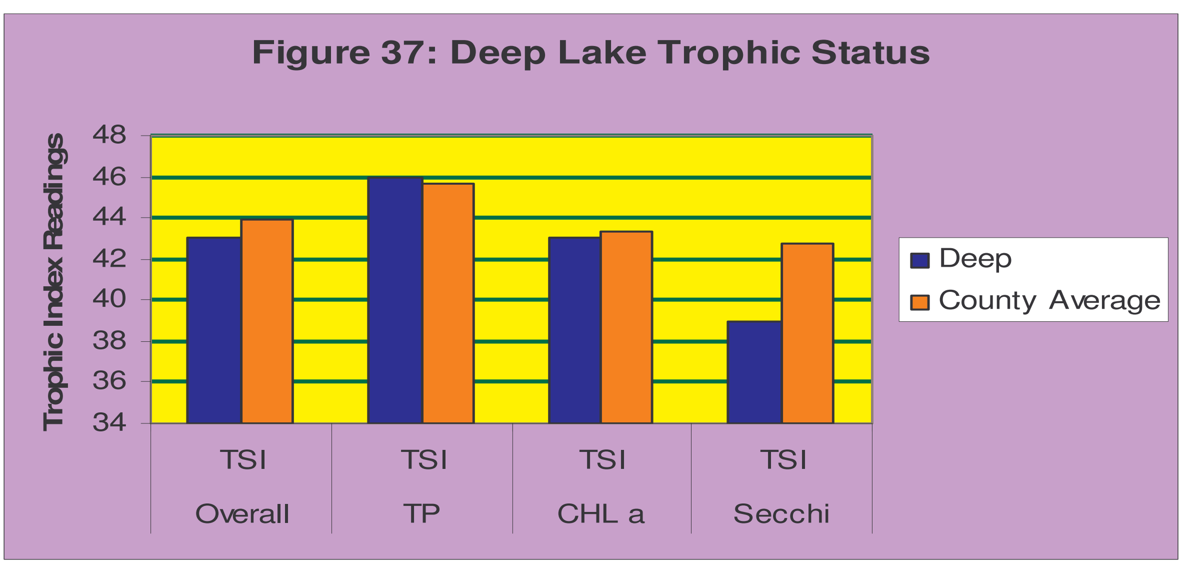
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average summer epilimnetic total phosphorus for Deep Lake was 18.42 micrograms/liter. The average summer chlorophyll-a concentration was 3.6 milligrams/liter. Growing season water clarity averaged a depth of 12.96 feet. Figure 36 shows where each of these measurements from Deep Lake fall in trophic level.

Figure 36: Deep Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(mg/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	**1 to 5**	**8 to 19**
Mesotrophic	Good	**10 to 30**	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Deep Lake		**18.42**	**3.6**	**12.96**

These figures show that Deep Lake has low levels overall for the three parameters often used to describe water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. According to these results, Deep Lake scores as "mesotrophic" in its phosphorus level, and "oligotrophic" in chlorophyll-a readings and Secchi disk readings. With such phosphorus readings and chlorophyll a readings, dense plant growth and frequent algal blooms would not be expected.

Deep Lake ranks about average for natural lakes in Adams County in two parameters and lower than the average for water clarity. In the TSI index, ranking lower is a positive factor.



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

An aquatic plant survey was done on Deep Lake in the summer of 2005 by staff from the Adams County LWCD. The results verified that Deep Lake is a borderline mesotrophic/oligotrophic lake with very good water quality and excellent water clarity. Filamentous algae are present in Deep Lake, with the highest presence found in the 0-1.5 feet depth zone.

The aquatic plant community colonized 100% of Deep Lake's littoral zone, with 100% a maximum rooting depth of 20 feet. The 0 to 1.5 foot depth zone supported the most abundant aquatic plant growth. Species richness was 4.16 in the lake. The Deep Lake aquatic plant community is characterized by above average water quality and good species diversity. The plant community is closer to an undisturbed condition than the average lake in the state.

Of the 23 species found in Deep Lake, seven were emergent, one was a floating-leaf rooted plant, and fourteen were submergent types. One plant-like algae, *Chara* spp. (muskegrass), was also found at nearly all sample sites. No free-floating plant species were found. No endangered or threatened species were found. One exotic invasive, *Phalaris arundinacea* (reed canarygrass), was found at one transect.

Ceratophyllum demersum (coontail) was the most frequently occurring plant species in Deep Lake, although *Chara* spp. was the most frequently-occurring aquatic species. *Potamogeton amplifolius (*large-leaf pondweed) and *Potamogeton zosteriformis* (flat-stemmed pondweed) were the next most frequently-occurring plants in Deep Lake in 2005. *Chara* spp. was the aquatic species with the highest mean density. Aquatic plant species with the highest mean density in Deep Lake were *Ceratophyllum demersum, Potamogeton amplifolius,,* and *Potamogeton zosteriformis.* Based on dominance value, *Chara* spp. was the dominant aquatic species in Deep Lake. The dominant plant species was *Ceratophyllum demersum. Potamogeton amplifolius* and *Potamogeton zosteriformis* were sub-dominant overall.

Figure 38: Deep Lake Aquatic Plant Species 2005

Scientific Name			Common Name
Emergent Species			
Carex spp.			sedge
Cirsium spp.			thistle
Iris versicolor			blue flag iris
Phalaris arundinacea			reed canarygrass
Polygonum amphibirum			water smartweed
Scirpus validus			soft-stem bulrush
Typha latifolia			narrow-leaf cattail
Floating-Leaf			
Nuphar spp			yellow pond lily
Submergent Species			
Ceratophyllum demersum			coontail
Eleocharis palustris			creeping spikerush
Elodea canadensis			common waterweed
Myriophyllum sibircum			northern watermilfoil
Najas flexilis			bushy pondweed
Najs guadelupensis			southern naiad
Potamogteon amplifolius			large-leaf pondweed
Potamogeton diversifolius			variable-leaf pondweed
Potamogeton foliosus			leafy pondweed
Potamogeton pectinatus			sago pondweed
Potamogeton praelongus			white-stem pondweed
Potamogeton pusillus			small pondweed
Potamogeton richarsonii			clasping-leaf pondweed
Potamogton zosteriformis			flat-stem pondweed
Plant-like Algae			
Chara spp.			muskgrass

The study used the results of the 2005 field survey to evaluate Deep Lake by using several standard community measurements. For example, the Simpson's Diversity Index was 0.89, indicating very good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) for Deep Lake was 58. This is above average for lakes in Wisconsin and average for the North Central Hardwoods Region of the state.

Previously, a value was assigned to all plants known in Wisconsin to categorize their probability of occurring in an undisturbed habitat. This value is called the plant's Coefficient of Conservatism. A score of 0 indicates a native or alien opportunistic invasive plant. Plants with a value of 1 to 3 are widespread native plants. Values of 4 to 6 describe native plants found most commonly in early successional ecosystem. Plants scoring 6 to 8 are native plants found in stable climax conditions. Finally, plants with a value of 9 or 10 are native plants found in areas of high quality and are often endangered or threatened. In other words, the lower the numerical value a plant has, the more likely it is to be found in disturbed areas. The Average Coefficient of Conservation for Deep Lake was 5.24. This indicates that the current aquatic plant community in Deep Lake is slightly below the average for Wisconsin Lakes (6.0) and for lakes in the North Central Hardwood Region (5.6). The current aquatic plant community appears to have started to respond to some past disturbances, but has not yet been heavily impacted by them.

Floristic Index measures the community's closeness to an undisturbed condition. The Floristic Quality Index of the aquatic plant community in Deep Lake of 24+ is above average for Wisconsin Lakes (22.2) and in the upper quartile for lakes in the North Central Hardwood Region (20.9). This indicates that the plant community in Deep Lake is in the group of lakes closest to an undisturbed condition in Wisconsin overall and in the North Central Hardwood Region. In other words, the aquatic plant community in Deep Lake appears not to have been significantly impacted by a high amount of disturbance.

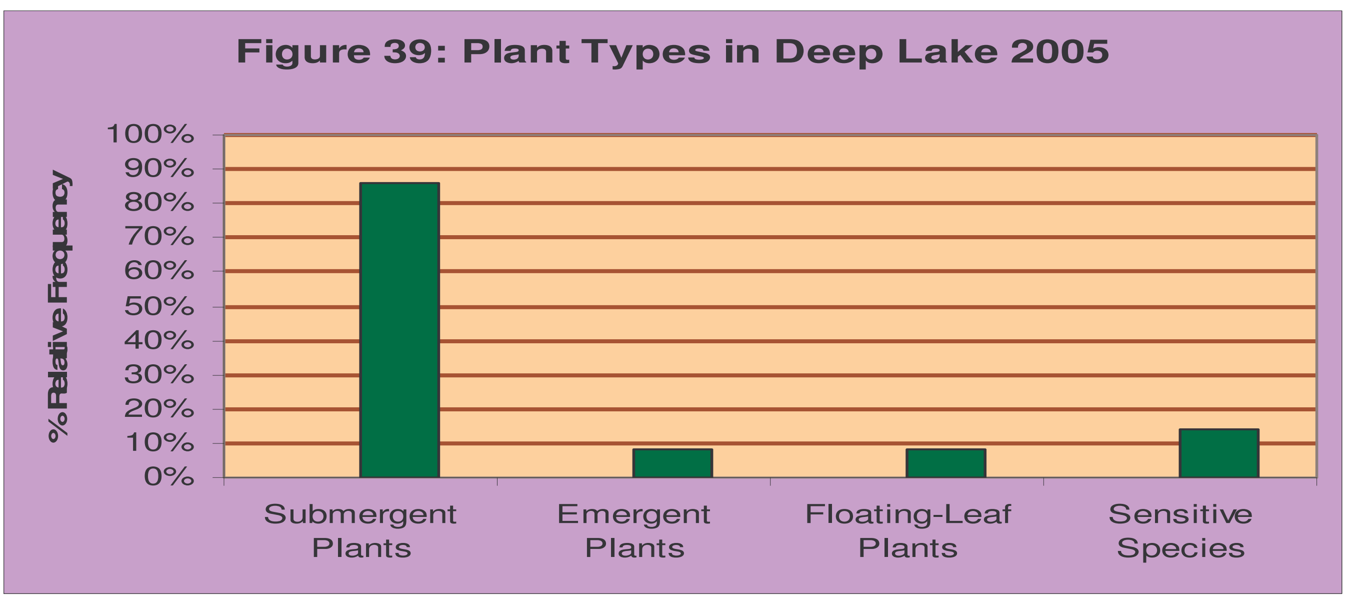


Figure 40a: Emergent Aquatic Plants in Deep Lake (2005)

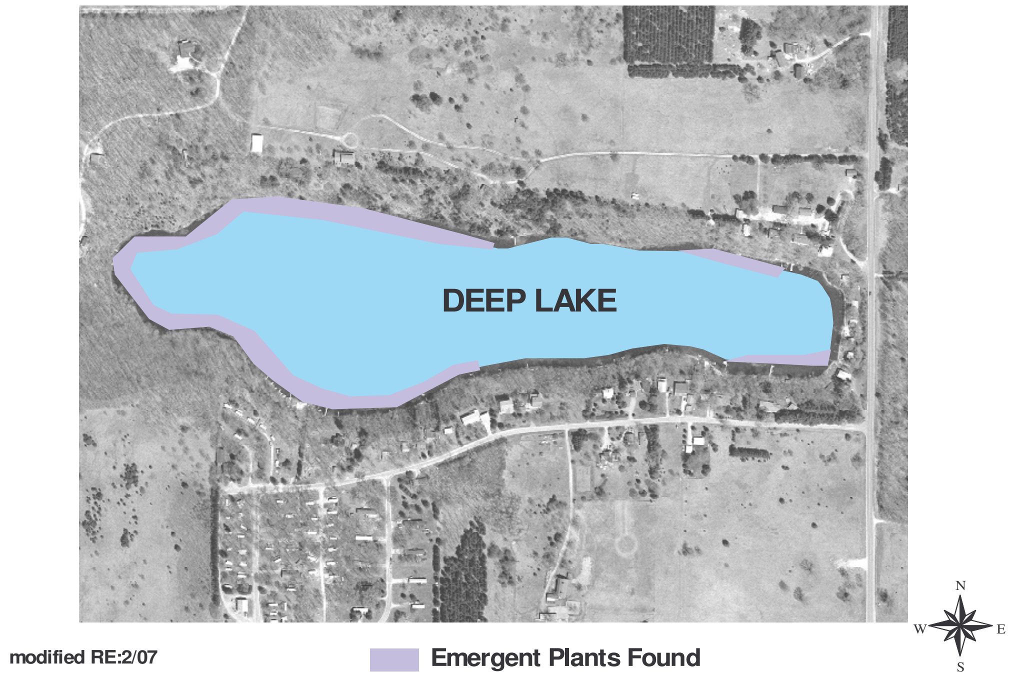


Figure 40b: Free-Floating & Floating Leaf Plants in Deep Lake 2005

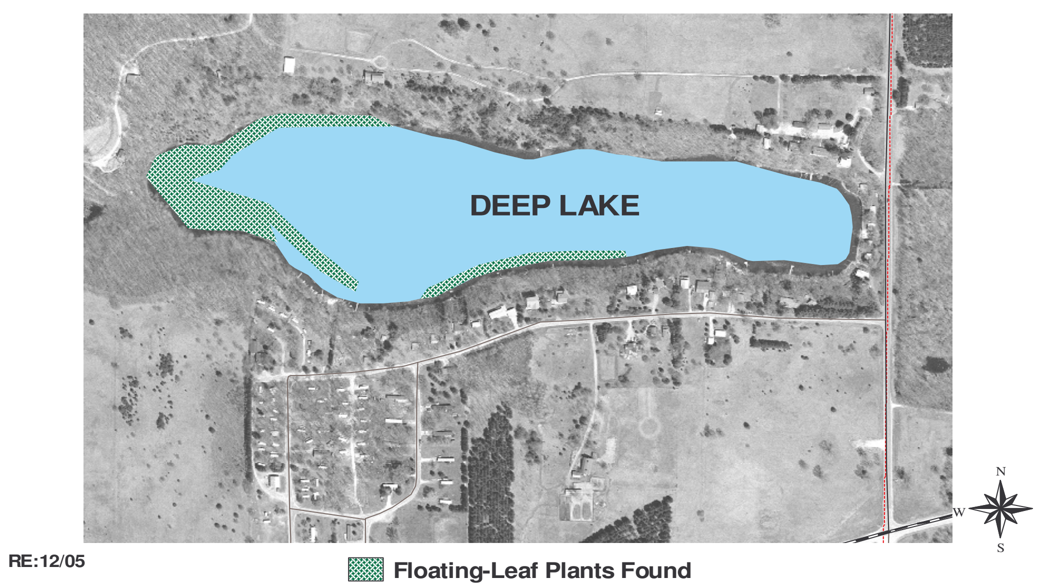


Figure 40c: Submergent Aquatic Species in Deep Lake (2005)

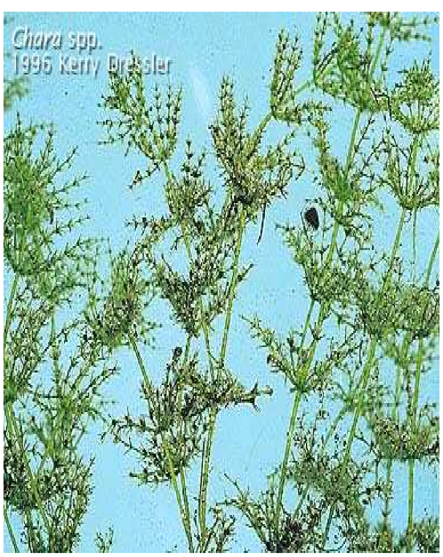


Figure 41: Most Common Native Aquatic Specie and Native Aquatic Plant in Deep Lake

***Certaophyllum demersum* (coontail), most common aquatic plant specie**

***Chara* spp (Muskgrass), Most common species**

Aquatic Invasives

Deep Lake currently has no invasive aquatic plants reported except for *Phalaris arundinacea* (reed canarygrass), an emergent. It was found in only one spot on the lake in very low density. The lake may have been protected from the introduction of many of the invasive aquatic plants common in Adams County because it lacks a public boat launch.

However, there should be ongoing monitoring on the lake to watch for the introduction of any invasive aquatic species. This is the best way to identify invasive threats before they get well established and take action to discourage them. Currently, Deep Lake has no lake organizations of any kind that could help in the monitoring. To protect the lake from invasions, some kind of lake organization should be formed that could monitor for invasives and seek appropriate action, should they be identified at the lake.

Figure 42: *Phalaris arundinacea* (Reed canarygrass)

Critical Habitat

Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

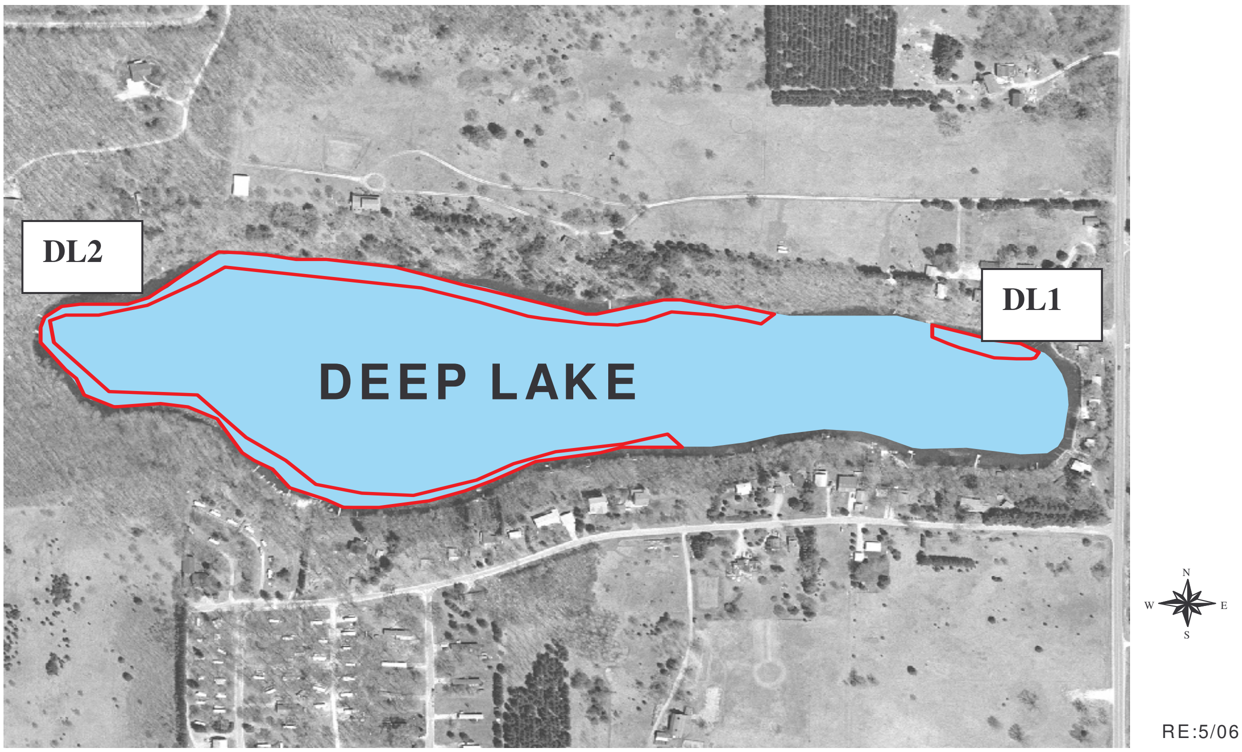
Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shore.

Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

Field work for a critical habitat study was performed on May 24, 2006, on Deep Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Terence Kafka, DNR Water Regulation; James Keir, DNR Wildlife Biologist; Deborah Konkel, DNR Aquatic Plant Specialist; Patrick (Buzz) Sorge, DNR Lakes Manager, and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with GPS readings and digital photos providing additional information.

Two areas on Deep Lake were determined to be appropriate for critical habitat designation. They are shown in Figure 43. Common criteria for both of them included the water quality, whether the areas provide nutrient, biological and/or physical buffers, the quality of the aquatic plant community present, and wildlife and fish habitat provisions.

Figure 43: Critical Habitat Areas on Deep Lake



Critical habitat DE1

This area extends along approximately 300 feet of the shoreline. 10% of the shore is wooded; 55% has shrubs; 25% is native herbaceous cover; 5% is rock and 5% is hard structure. Large woody cover is present. This is a small area of the lake between a resort that has a riprapped shore and a stairway and dock going to another residence. There are downed trees in the water at this site that provide fish habitat and wildlife structure.

This small area of large woody cover and submergent vegetation provides spawning and nursery areas for many types of fish: northern pike; largemouth bass; bluegill; pumpkinseed; yellow perch; crappie; bullhead; suckers, and other panfish. All of these fish also feed and take cover in these areas. No exotic aquatic wildlife was noted in this area, i.e, no carp, smelt or rusty crayfish were seen. Trout are stocked in Deep Lake, but do not spawn there.

Seen during the field survey were various types of waterfowl and songbirds, as well as reptiles and amphibians. Various upland wildlife are known to use this area.

No filamentous algae were found at this site. One emergent exotic invasive was found in this area, *Phalaris arundinacea* (reed canarygrass). Maximum rooting depth of aquatic vegetation in DE1 was 18.5 feet. Ten species of submergents were found in DE1. The only emergent plant found was *Phalaris arundinacea*..

Figure 44: Photo of Most of Area DE1

Critical habitat DE2

This area extends along approximately 4300 feet of the shoreline. 54% of the shore is wooded; 7% has shrubs; 28% is native herbaceous cover, with 10% rock, 7% hard structure and 3% bare sand. Large woody cover is abundant for habitat. There are shallow marsh areas along many areas of this shoreline. With only a little human disturbance along this shoreline, the area is scenic.

Maximum rooting depth in DE2 was 20 feet. No threatened or endangered species were found in this area. One emergent exotic invasive, *Phalaris arundinacea*, was found in this area. 29% of the area has filamentous algae, especially near the shores. Of the 20 aquatic plant species found here, seven were emergent. Emergents provide important fish habitat and spawning areas, as well as areas for wildlife. Two plants were floating-leaf rooted plants. Floating-leaf plants provide cover and dampen waves, protecting the shore. The remaining eleven species were submergent aquatic plant species. Such a diverse submergent community provides many benefits. All these plants are used for multiple purposes. Because this site provides three structural types of vegetation, the community has a diversity of structure and species that support even more fish and wildlife diversity.

Figure 45: Part of DE2

Recommendations for Critical Habitat Areas

(1) Maintain current habitat for fish and wildlife.
(2) Maintain wildlife corridor.
(3) Do not remove fallen trees along the shoreline nor logs in the water.
(2) No alteration of littoral zone unless to improve spawning habitat.
(3) Seasonal protection of spawning habitat.
(4) Maintain snag/cavity trees for nesting.
(5) Maintain no-wake zone.
(6) Minimize human development, especially to protect the great blue heron rookery.
(7) Protect emergent and floating-leaf vegetation for habitat and water quality protection.
(8) Removal of submergent vegetation only and for navigation only.
(9) Reduce presence of Reed Canarygrass.
(9) Minimize aquatic plant and shore plant removal to 30’ wide access/viewing corridor.
(10) Use forestry best management practices.

(11) No use of lawn products.
(12) No bank grading or grading of adjacent land.
(13) No pier construction or other activity except by permit using a case-by-case evaluation.
(14) No installation of pea gravel or sand blankets.
(15) No bank restoration unless the erosion index scores moderate or high.
(16) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(17) Placement of swimming rafts or other recreational floating devices only by permit.
(18) Maintain buffer of shoreline vegetation.
(19) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(20) Minimize development of shore and steep banks that would increase erosion and decrease water quality.

Figure 46: Fall Photo of DE2

FISHERY/WILDLIFE/ENDANGERED RESOURCES

A 1948 fishery inventory of Deep Lake found that bluegills were abundant, black crappie & yellow perch were common, but other fish types were scarce. It described Deep Lake as "infertile, with moderate to scarce plankton, suitable for trout, moderate to sparse vegetation with little shallow area". It noted that there was not heavy fishing pressure on Deep Lake.

Stocking records go back to 1942 when perch and largemouth bass were stocked. Bluegills and largemouth bass were stocked through the 1940s. In the 1960s and 1990s, brown and rainbow trout were stocked. Inventories from 1953 through 1979 noted that largemouth bass, rock bass, bluegills and other panfish were abundant or common. Northern pike tended to be scarce.

Muskrat and mink are also known to use Deep Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. A blue heron rookery is known at the west end of the lake. Upland wildlife feed and nest here as well.

Figure 47: Blue Heron Rookery (not the one at Deep Lake)

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Figure 48: Photo of a Lake in Algal Bloom

Figure 49: Fall Photo of Deep Lake